

REPORT NUMBER: 214P-CAL-19-009

**SAFETY COMPLIANCE TESTING FOR FMVSS 214
DYNAMIC SIDE IMPACT PROTECTION
RIGID POLE TEST**

**Bayerische Motoren Werke AG
2019 BMW 230i
Two Door Convertible**

NHTSA No: C20194100

**PREPARED BY:
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June 18, 2019

FINAL REPORT

**PREPARED FOR:
U.S. DEPARTMENT OF TRANSPORTATION
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ENFORCEMENT
OFFICE OF VEHICLE SAFETY COMPLIANCE
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WASHINGTON, D.C. 20590**

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16. Abstract <p>A 31.00 km/h (19.3 mph), 285° oblique compliance test was conducted on the subject 2019 BMW 230i two door convertible in accordance with the specifications of the Office of Vehicle Safety Compliance TP-214P-01 for the determination of FMVSS No.214 Side Impact Protection compliance. The test was conducted at Calspan Corporation's Transportation Test Operations facility in Buffalo, New York on May 16, 2019.</p> <p>The impact velocity of the vehicle was 30.96 km/h, and the ambient temperature at the struck (passenger's) side of the target vehicle was 21°C. The target vehicle's maximum post-test static crush was 280 mm located at level 3. The test vehicle's occupant performance data is as follows:</p> <table border="1"> <thead> <tr> <th rowspan="2">Measurement Description</th> <th colspan="3">Front Passenger ATD (ES-2re)</th> </tr> <tr> <th>Units</th> <th>IARV</th> <th>Result</th> </tr> </thead> <tbody> <tr> <td>Head Injury Criteria (HIC₃₆)</td> <td>N/A</td> <td>1000</td> <td>91.581</td> </tr> <tr> <td>Maximum Thoracic Rib Deflection</td> <td>mm</td> <td>44</td> <td>26.660</td> </tr> <tr> <td>Total Abdominal Force</td> <td>N</td> <td>2500</td> <td>844.276</td> </tr> <tr> <td>Pubic Symphysis Force</td> <td>N</td> <td>6000</td> <td>2257.569</td> </tr> </tbody> </table> <p>The two doors on the struck side of the vehicle did not separate from the body at the hinges or latches and the opposite doors did not open during the side impact event.</p>				Measurement Description	Front Passenger ATD (ES-2re)			Units	IARV	Result	Head Injury Criteria (HIC ₃₆)	N/A	1000	91.581	Maximum Thoracic Rib Deflection	mm	44	26.660	Total Abdominal Force	N	2500	844.276	Pubic Symphysis Force	N	6000	2257.569
Measurement Description	Front Passenger ATD (ES-2re)																									
	Units	IARV	Result																							
Head Injury Criteria (HIC ₃₆)	N/A	1000	91.581																							
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Total Abdominal Force	N	2500	844.276																							
Pubic Symphysis Force	N	6000	2257.569																							
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Form DOT F1700.7 (8-72)

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SECTION 1

PURPOSE AND SUMMARY OF TEST

PURPOSE

This side impact test was conducted as part of the FY 2019 FMVSS 214 Side Impact Protection Compliance Test Program, sponsored by the National Highway Traffic Safety Administration (NHTSA), under Contract No. DTNH22-17-D-00078. The purpose of this test was to evaluate side impact protection in a 2019 BMW 230i two door convertible. The side impact test was conducted in accordance with the Office of Vehicle Safety Compliance's Laboratory Test Procedure, TP-214P-01 dated September 2012.

SUMMARY

A rigid pole side impact test was conducted on a 2019 BMW 230i two door convertible. The subject vehicle was towed into the rigid pole at an angle of 285° and a velocity of 30.96 km/h. The test was conducted by Calspan Corporation's Transportation Test Operations facility in Buffalo, New York on May 16, 2019. Pre-test and post-test photographs of the test vehicle and side impact dummy (ES2re) are included in Appendix I of this report.

One Part 572U (ES2re) dummy was placed in the front passenger designated seating position according to instructions specified in the TP-214P-01 Test Procedure, dated September 2012. The side impact event was documented by nine High Speed Cameras and one real time camera.

The ES2re male dummy was instrumented accordingly:

- Primary and redundant head CG tri-axial accelerometers
- Chest upper rib, middle rib, and lower rib y-axis displacement potentiometers
- Abdomen forward, middle, and rear y-axis load cells
- Lower spine (T12) tri-axial accelerometers
- Public symphysis y-axis load cell

Appendix II contains the dummy response data. Dummy configuration and performance verification data can be found in Appendix IV of this report. Appendix V identifies all serial numbers, manufacturers, and calibration dates for test equipment, dummy sensors, potentiometers, and load cells used to collect data during the test.

Injury readings for the ES2re dummy were recorded as follows:

INJURY READINGS

Measurement Description	Front Passenger ATD (ES2re)		
	Units	IARV	Result
HIC ₃₆		1000	91.581
Upper Rib Deflection	mm	44	26.660
Mid Rib Deflection	mm		21.860
Lower Rib Deflection	mm		22.687
Abdominal Load (front)	N		227.348
Abdominal Load (mid)	N		282.765
Abdominal Load (rear)	N		391.815
Sum of Abdomen Forces	N	2500	844.276
Pubic Symphysis	N	6000	2257.569

SECTION 2

OCCUPANT AND VEHICLE INFORMATION

This section contains information reporting for the following Data Sheets:

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DATA SHEET NO. 1
TEST VEHICLE INFORMATION AND OPTIONS

Test Vehicle: 2019 BMW 230i two door convertible
 Test Facility: Calspan

NHTSA No.: C20194100
 Test Date: 5/16/2019

TEST VEHICLE INFORMATION AND OPTIONS

Make	BMW	Anti-Lock Brakes (ABS)	Yes
Model	230i	All-Wheel Drive (AWD)	No
Body Style	Two Door Convertible	Traction Control System (TCS)	Yes
VIN	WBA2M7C51KVD52295	Electric Stability Control (ECS)	Yes
Body Color	White	Curtain Airbags	No
Engine Displacement (L)	2.0	Torso Airbags – Front Seats	No
Type/No. Cylinders	I4	Torso Airbags – Rear Seats	No
Engine Placement	Inline	Combination/Head Torso Bag	Yes
Transmission Type	Automatic	Pelvic Airbag – Front Seats	No
Transmission Speeds	8-Speed	Pelvis Airbag – Rear Seats	No
Overdrive	Yes	Knee Airbag – Driver	Yes
Final Drive	Rear Wheel Drive	Knee Airbag – Front Passenger	No
Odometer Reading (mi)	26 miles	Seat Belt Pretensioners – Front Seats	Yes
		Seat Belt Pretensioners – Rear Seats	No
		Seat Belt Load Limiter – Front Seats	Yes
		Seat Belt Load Limiter – Rear Seats	No
		Tire Pressure Monitoring System	Yes
		Tilt Steering Wheel	Yes
		Automatic Door Locks (ADL)	Yes
		Power Window Auto-reverse	Yes
		Power Seats	Yes

DATA FROM CERTIFICATION LABEL

Manufactured By	Bayerische Motoren Werke AG	GVWR (kg)	2025
Date of Manufacture	10/18	GAWR Front (kg)	935
Vehicle Type	Passenger Car	GAWR Rear (kg)	1130

VEHICLE SEATING AND CAPACITY WEIGHT DATA

Measured Parameter	Front	Rear	Third	Total
Type of Seats (Bench or Bucket)	Bucket	Bench	N/A	
Designated Seating Capacity (DSC)	2	2	N/A	4
Capacity Weight (VCW) (kg)				308
Cargo Weight (RCLW) (kg)				35.84

DATA SHEET NO. 2

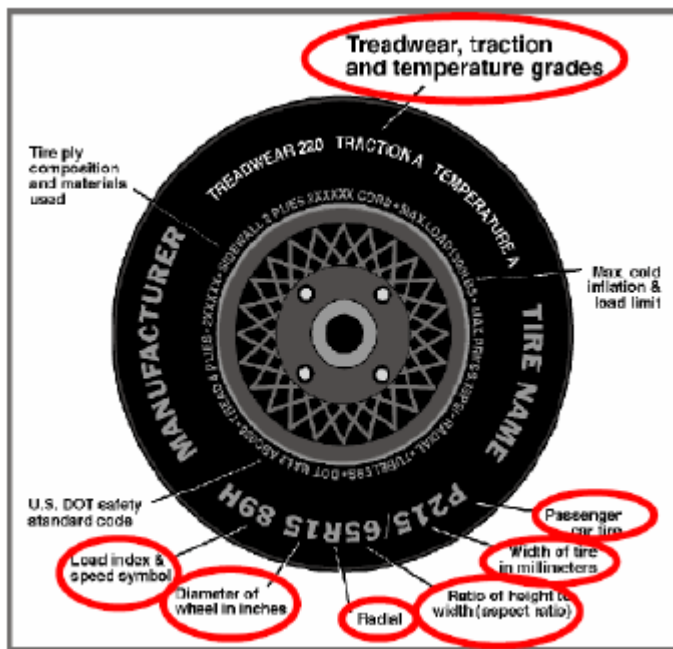
VEHICLE TIRE INFORMATION

Test Vehicle: 2019 BMW 230i two door convertible
Test Facility: Calspan

NHTSA No.: C20194100
Test Date: 5/16/2019

VEHICLE TIRE INFORMATION

Collected for year, make, model, & VIN, all items circled in red, tire manufacturer and tire name.



TIRE SIDEWALL INFORMATION

Tire Placard	Front	Rear
Recommended Cold Pressure (kPa)	220	260
Recommended Tire Size	205/50R17	205/50R17
Tire Sidewall	Front	Rear
Maximum Tire Pressure (kPa)	350	350
Tire Size on Vehicle	205/50R17	205/50R17
Tire Manufacturer Model	Bridgestone	Bridgestone
Tire Name	Turanza EL400	Turanza EL400
Tire Type	All Season	All Season
Tire Width	205	205
Aspect Ratio	50	50
Radial	Yes	Yes
Wheel Diameter	17"	17"
Load Index/Speed Symbol	89V	89V
Treadwear	260	260
Traction Grade	A	A
Temperature Grade	A	A

DATA SHEET NO. 3
GENERAL TEST AND VEHICLE PARAMETER DATA

Test Vehicle: 2019 BMW 230i two door convertible
 Test Facility: Calspan

NHTSA No.: C20194100
 Test Date: 5/16/2019

TIRE PRESSURES

	Units	LF	RF	LR	RR
As Delivered	kPa	280	280	300	300
As Tested	kPa	220	220	260	260

TEST VEHICLE AXLE WEIGHTS

	Units	As Delivered (UVW)			Fully Loaded			As Tested		
		Front	Rear	Total	Front	Rear	Total	Front	Rear	Total
Left	kg	416	430		422	463		426	457	
Right	kg	412	424		443	476		436	471	
Ratio	%	49	51		48	52		48	52	
Totals	kg	828	854	1682	865	939	1804	862	928	1790

TARGET TEST WEIGHT CALCULATION

Measured Parameter	Units	Value	
As Delivered Weight (UVW)	kg	1682	(A)
Weight of Test Dummy	kg	81	(B)
Rated Cargo / Luggage Weight (RCLW)	kg	35.84	(C)
Calculated Vehicle Target Weight (TVTW)	kg	1798.84	(A+B+C)

TEST VEHICLE ATTITUDES AND CG

Measurement Description	Units	As Delivered	Fully Loaded	As Tested
Left Door Sill Angle	Deg	0.15	-1.2	-0.7
Right Door Sill Angle	Deg	-1.3	-1.3	-1.3
Front Bumper – Line Angle	Deg	-1.9	0.0	-0.4
Rear Bumper – Line Angle	Deg	1.5	0.75	0.8

ND = Nose Down (-), NU = Nose Up (+), LD = Left Down (-), LU = Left Up (+)

CALCULATION OF VERTICAL IMPACT REFERENCE LINE

Measured Parameter	Units	Value
Test Vehicle Wheelbase	mm	2689
Vertical Impact Reference Line Aft of Front Axle	mm	1528

WEIGHT OF BALLAST AND VEHICLE COMPONENTS REMOVED TO MEET TVTW

Component Description	Weight (kg)
Trunk carpeting	7
Tail light	1
Ballast (if any)	5

DATA SHEET NO. 4
SEAT AND SEAT BELT ANCHORAGE ADJUSTMENT DATA

Test Vehicle: 2019 BMW 230i two door convertible
 Test Facility: Calspan

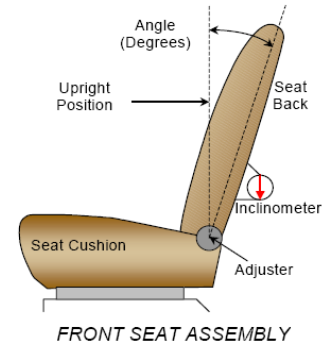
NHTSA No.: C20194100
 Test Date: 5/16/2019

SEAT BACK ANGLE ADJUSTMENT

The driver and passenger seat backs are positioned to the manufacturer's designated angle provided in the Form1.

	Units	Seat Back Angle
Driver Seat	deg	9.3
Front Passenger Seat	deg	9.3

*Measurement taken on seatback



SEAT HEIGHT AND ANGLE

Seat	As Tested SCRL Angle (Mid) (°)	SCR P Height Position	SCR P Height (mm)		
			Rearmost	Mid-Fore / Aft	Forward-Most
Driver Seat	18.1	Max	68	81	94
		Mid	38	51	64
		Min	8	21	34
Front Passenger Seat	18.2	Max	68	81	94
		Mid	38	51	64
		Min	8	21	34

SEAT FORE / AFT POSITION

Seat	Total Fore / Aft Travel		Placed in Position #	
	mm	Detents*	mm	Detents*
Driver Seat	247	N/A	124	N/A
Front Passenger Seat	247	N/A	124	N/A

SEAT BELT ANCHORAGE ADJUSTMENT

Seat	Total # of Positions	Placed in Position #
Driver Seat	Fixed	Fixed
Front Passenger Seat	Fixed	Fixed

HEAD RESTRAINT ADJUSTMENT

Seat	Total # of Positions	Placed in Position #
Driver Seat	5	Uppermost
Front Passenger Seat	5	Uppermost

DATA SHEET NO. 5
FUEL SYSTEMS AND STEERING WHEEL POSITION DATA

Test Vehicle: 2019 BMW 230i two door convertible
 Test Facility: Calspan

NHTSA No.: C20194100
 Test Date: 5/16/2019

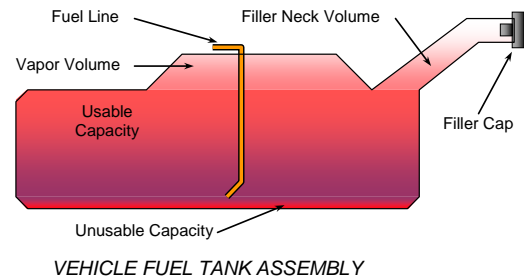
FUEL TANK CAPACITY DATA

Description	Liters
Usable Capacity (Form No. 1)	52
Usable Capacity (Owner's Manual)	52
92 - 94% of Usable Capacity	47.8 – 48.9
Actual Amount of Solvent Used in Test	48.4

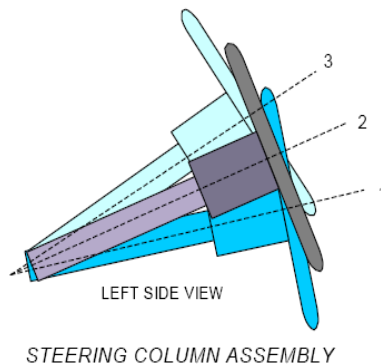
FUEL PUMP

Describe the operation of the fuel pump.

The vehicle is equipped with an electric fuel pump.
 The fuel filler neck is on the right side of the vehicle.
 The pump creates positive pressure in the fuel lines,
 pushing the gasoline to the engine. See form 1 for
 more information.



STEERING COLUMN ADJUSTMENT

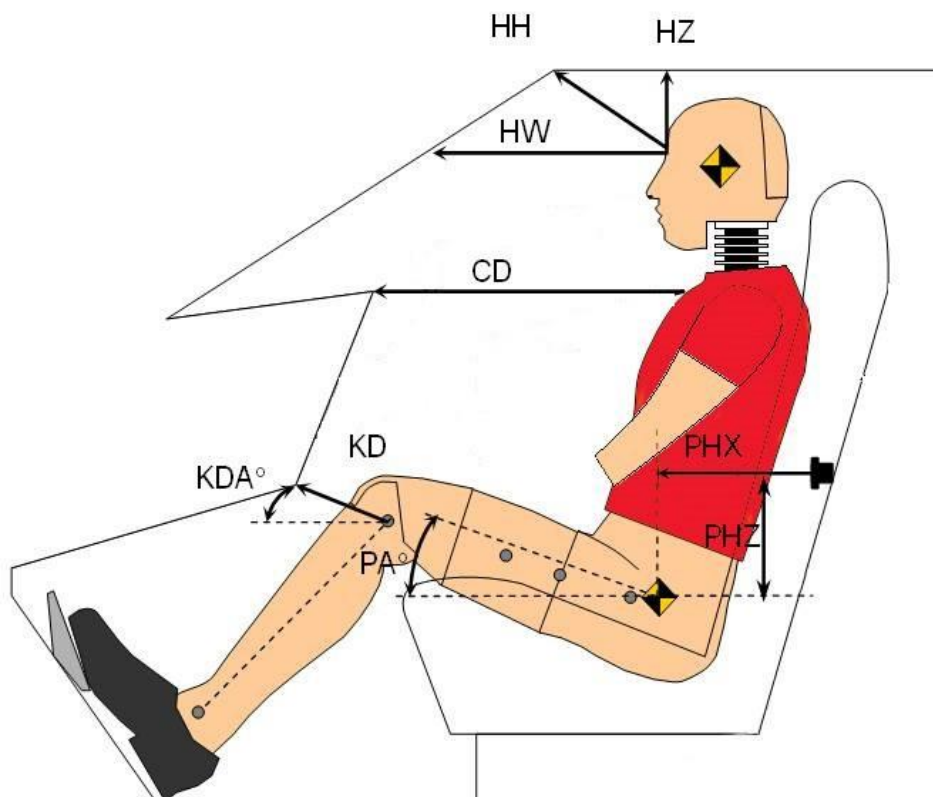


	Degrees	Fore / Aft Position (mm)
Lowermost – Position 1	17.3	
Geometric Center – Position 2	19	
Uppermost – Position 3	20.7	
Telescoping Steering Wheel Travel		60
Test Position	19	30

DATA SHEET NO. 6
DUMMY LONGITUDINAL CLEARANCE DIMENSIONS

Test Vehicle: 2019 BMW 230i two door convertible
 Test Facility: Calspan

NHTSA No.: C20194100
 Test Date: 5/16/2019



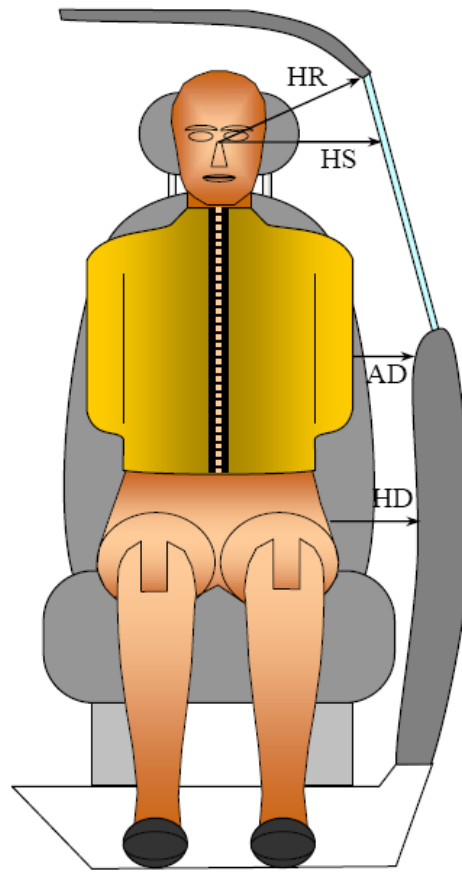
DUMMY LONGITUDINAL CLEARANCE DIMENSION INFORMATION

Driver Code	Description	Front Passenger	
		Length (mm)	Angle (°)
HH	Head to Header	418	
HW	Head to Windshield	637	
HZ	Head to Roof Liner	185	
CD	Chest to Dash	555	
KD(L) / KDA(L)°	Left Knee to Dash	171	33.8
KD(R) / KDA(R)°	Right Knee to Dash	218	44.6
PAX°	Pelvic Tilt Angle (X-Axis)		0.3
PAY°	Pelvic Tilt Angle (Y-Axis)		26.2
PHX	Hip Point to Striker (X-Axis)	350	
PHZ	Hip Point to Striker (Z-Axis)	281	

DATA SHEET NO. 7
DUMMY LATERAL CLEARANCE DIMENSIONS

Test Vehicle: 2019 BMW 230i two door convertible
Test Facility: Calspan

NHTSA No.: C20194100
Test Date: 5/16/2019



FRONT VIEW OF DUMMY

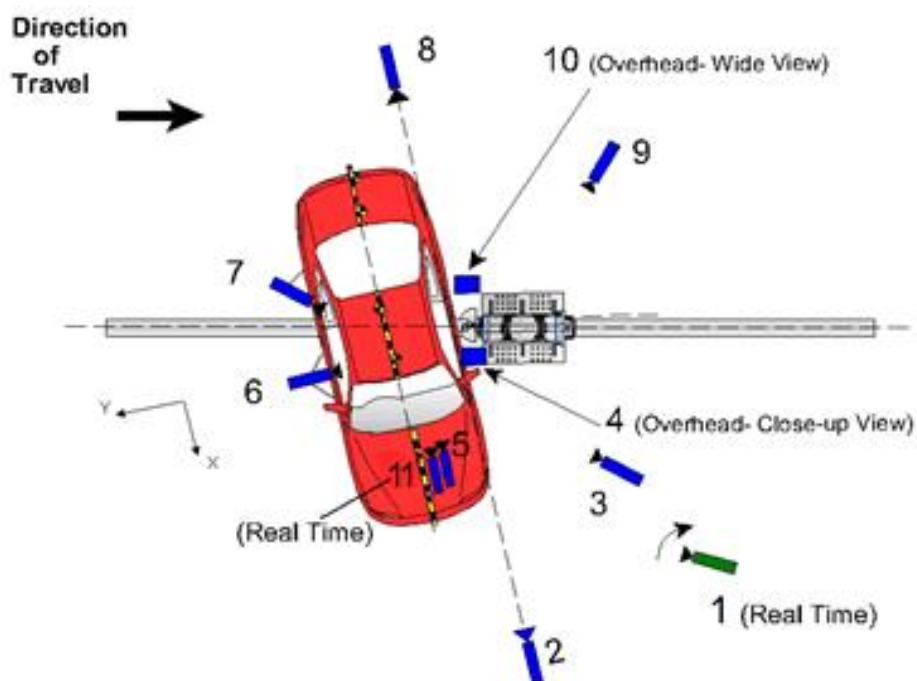
DUMMY LATERAL CLEARANCE DIMENSION INFORMATION

Code	Measurement Description	Units	Front Passenger
HR	Head To Side Header	mm	235
HS	Head to Side Window	mm	304
AD	Arm to Door	mm	95
HD	Hip Point to Door	mm	155

DATA SHEET NO. 8 LOCATION OF CAMERAS

Test Vehicle: 2019 BMW 230i two door convertible
Test Facility: Calspan

NHTSA No.: C20194100
Test Date: 5/16/2019



CAMERA LOCATIONS AND DATA

No.	Camera View	Coordinates (mm)			Lens Length (mm)	Operating Frame Rate (fps)
		X	Y	Z		
1	Real-time (24 - 30 fps) pan view of impact				Zoom	60
2	Front ground level - impact view	7929	0	-1543	28	1000
3	Impact side 45° - forward pole view	6148	-2034	-1310	24	1000
4	Overhead Close-up view of impact	0	0	-9370	28	1000
5	Onboard - dummy front view				25	1000
6	Onboard - dummy side view				8	1000
7	Onboard - dummy rear oblique view				8	1000
8	Rear ground level - impact view	8603	0	-1189	28	1000
9	Impact side 45° - rearward pole view	4155	-3624	-1396	24	1000
10	Overhead wide - view of impact	0	0	-9370	12.5	1000

Notes: Reference - From Point of Impact for X and Y; from Ground for Z

+X = Forward of vehicle, +Y = Right of vehicle, +Z = Down

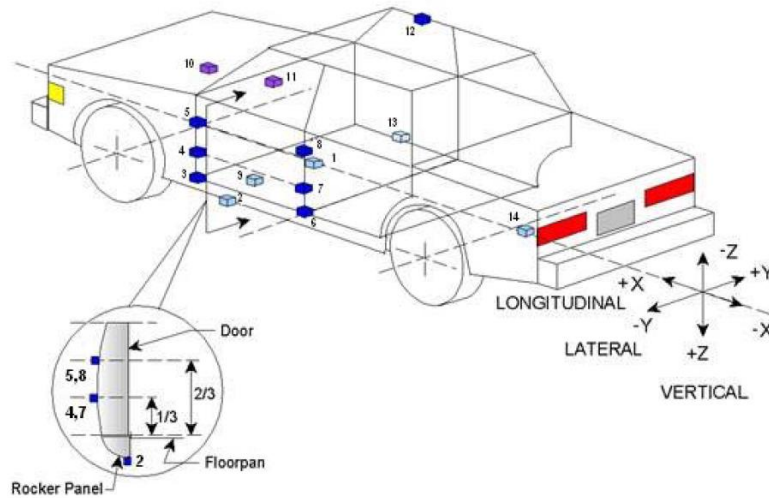
* All measurements accurate to ± 6 mm.

Vehicle is at a 285° angle to the rigid pole.

DATA SHEET NO. 9 **TEST VEHICLE ACCELEROMETER LOCATIONS**

Test Vehicle: 2019 BMW 230i two door convertible
 Test Facility: Calspan

NHTSA No.: C20194100
 Test Date: 5/16/2019



TEST VEHICLE ACCELEROMETER LOCATIONS

No.	Accelerometer Location	Coordinates (mm)		
		X	Y	Z
1	Vehicle CG	2280	41	-47
2	Left Floor Sill	2615	710	281
3	A-Pillar Sill	3018	621	217
4	A-Pillar Low	3069	621	87
5	A-Pillar Mid	2814	613	-406
6	B-Pillar Sill	1838	697	340
7	B-Pillar Low	1788	646	-8
8	B-Pillar Mid	1629	680	-444
9	Seat	2027	602	319
10	Engine	3643	36	-255
11	Firewall	3174	189	-246
12	Roof	1779	-540	-752
13	Right Floor Sill	2613	-698	250
14	Rear Deck	811	9	74

Reference: X – Rear surface of vehicle (+ forward)
 Y – Vehicle centerline (+ to right)
 Z – Ground plane (+ down)

DATA SHEET NO. 10
TEST VEHICLE ACCELEROMETER DATA SUMMARY

Test Vehicle: 2019 BMW 230i two door convertible
 Test Facility: Calspan

NHTSA No.: C20194100
 Test Date: 5/16/2019

Loc No.	Description	Axes	Units	Peak Values (g's)			
				Max	Time (ms)	Max	Time (ms)
1	Vehicle CG	X	g	6.81	9.90	-11.16	39.10
		Y	g	0.86	133.95	-27.33	33.40
		Z	g	27.34	22.20	-27.66	29.20
		Resultant		30.08	29.25	0.02	-7.15
2	Floor Sill (Impact Side)	Y	g	0.97	137.45	-22.27	14.00
3	A Pillar Sill	Y	g	60.67	54.25	-66.65	59.25
4	A Pillar Low	Y	g	72.74	55.80	-56.88	64.10
5	A Pillar Mid	Y	g	0.33	4.90	-16.26	68.55
6	B Pillar Sill	Y	g	1.52	1.35	-50.80	16.20
7	B Pillar Low	Y	g	11.05	34.55	-76.41	9.65
8	B Pillar Mid	Y	g	18.29	22.60	-64.99	12.90
9	Seat	Y	g	0.39	48.35	-7.97	17.40
10	Engine	X	g	9.23	99.50	-8.82	50.10
		Y	g	2.71	186.55	-21.57	44.40
11	Firewall	Y	g	0.47	3.80	-12.26	69.45
12	Roof	Y	g	12.13	78.80	-27.89	59.05
13	Floor Sill	Y	g	1.23	1.50	-49.86	8.30
14	Rear Deck	X	g	2.01	89.30	-6.03	40.55
		Y	g	0.62	136.90	-18.95	29.60

DATA SHEET NO. 11
DUMMY INJURY RESPONSE DATA
(Subpart U, ES-2re)

Test Vehicle: 2019 BMW 230i two door convertible
 Test Facility: Calspan

NHTSA No.: C20194100
 Test Date: 5/16/2019

Dummy Serial No. DG5348

Description	Axes	Positive Direction		Negative Direction	
		MAX	TIME (ms)	MAX	TIME (ms)
HEAD ACCELERATION (g)					
Longitudinal	X	6.10	30.05	-22.40	58.30
Lateral	Y	1.89	300.00	-24.31	49.90
Vertical	Z	10.64	28.10	-7.95	93.65
Resultant	N/A	30.35	56.60		
HIC36 (t1, t2)	N/A	91.58		t1 = 33.70	t2 = 69.70
THORAX DEFLECTION (mm)					
Upper Rib	Y	26.66	59.35	-0.27	17.00
Middle Rib	Y	21.86	48.15	-0.01	16.25
Lower Rib	Y	22.69	48.45	-0.03	80.65
ABDOMINAL FORCES (N)					
Front	Y	227.35	52.55	-19.54	19.25
Middle	Y	282.77	49.40	-3.66	15.15
Rear	Y	391.81	42.75	-4.42	205.60
SUM	N/A	844.28	42.85		
PELVIS FORCES (N)					
Pubic Symphysis	Y	34.36	182.35	-2257.57	40.00

Reference: Positive Direction - Longitudinal (X) = forward
 - Lateral (Y) = to right
 - Vertical (Z) = down

DATA SHEET NO. 12 POST-TEST OBSERVATIONS

Test Vehicle: 2019 BMW 230i two door convertible
Test Facility: Calspan

NHTSA No.: C20194100
Test Date: 5/16/2019

IMPACT POINT DATA

Measured Parameter	Units	Value
Vertical Impact Ref Line - Aft of Front Axle, Intended Impact Pt	mm	1528
Actual Impact Point - Aft of Front Axle	mm	1530
Difference	mm	2

TEST DUMMY INFORMATION AND CONTACT POINTS

Dummy Body Part	Front Passenger Seat Dummy (ES2re)
Head Contact	Combination Torso/Head Airbag
Upper Torso Contact	Combination Torso/Head Airbag
Lower Torso Contact	Combination Torso/Head Airbag
Left Knee Contact	Right Knee
Right Knee Contact	Passenger Door

POST-TEST DOOR PERFORMANCE

Description	Struck Side		Non-Struck Side		Rear Hatch/Other
	Front	Rear	Front	Rear	
Remained Closed and Operational	No	N/A	Yes	N/A	No*
Total Separation from Vehicle at Hinges or Latches	No	N/A	No	N/A	No
Latch or Hinge Systems Pulled Out of Their Anchorages	No	N/A	No	N/A	No
Disengaged from Latched Position	No	N/A	No	N/A	No
Latch Separated from Striker	No	N/A	No	N/A	No
If Door Opened at Striker, Width of Opening at Striker (mm)	0	N/A	0	N/A	0

*Rear hatch remained closed but once open could not be re-latched

POST-TEST SEAT PERFORMANCE

Description	Struck Side		Non-Struck Side	
	Front	Rear	Front	Rear
Seat Disengagement from Floor Pan	No	No	No	No
Seat Back Movement from Initial Position	No	No	No	No

POST-TEST STRUCTURAL OBSERVATIONS

Critical Areas of Performance	Observations and Conclusions
Pillar Performance	Remained in good condition
Sill Separation	None
Windshield Damage	None
Side Window Damage	Passenger window shattered during impact

DATA SHEET NO. 12
POST-TEST OBSERVATIONS (CONTINUED)

Test Vehicle: 2019 BMW 230i two door convertible
Test Facility: Calspan

NHTSA No.: C20194100
Test Date: 5/16/2019

SUPPLEMENTAL RESTRAINT SYSTEM INFORMATION

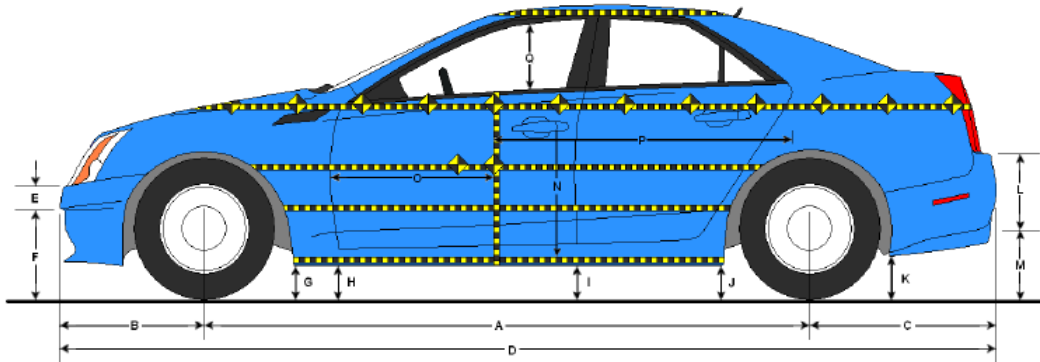
Restraint Type	Struck Side Front Occupant	
	Mounted	Deployed
Frontal Airbag	Yes	No
Side Torso Airbag	No	N/A
Head Airbag*	Yes	Yes
Curtain Airbag	No	N/A
Seat Belt Pretensioner	Yes	Yes
Other		

*Head Airbag was a combination bag with Torso Airbag

DATA SHEET NO. 13
VEHICLE PRE TEST AND POST TEST MEASUREMENTS

Test Vehicle: 2019 BMW 230i two door convertible
 Test Facility: Calspan

NHTSA No.: C20194100
 Test Date: 5/16/2019



LEFT SIDE VIEW

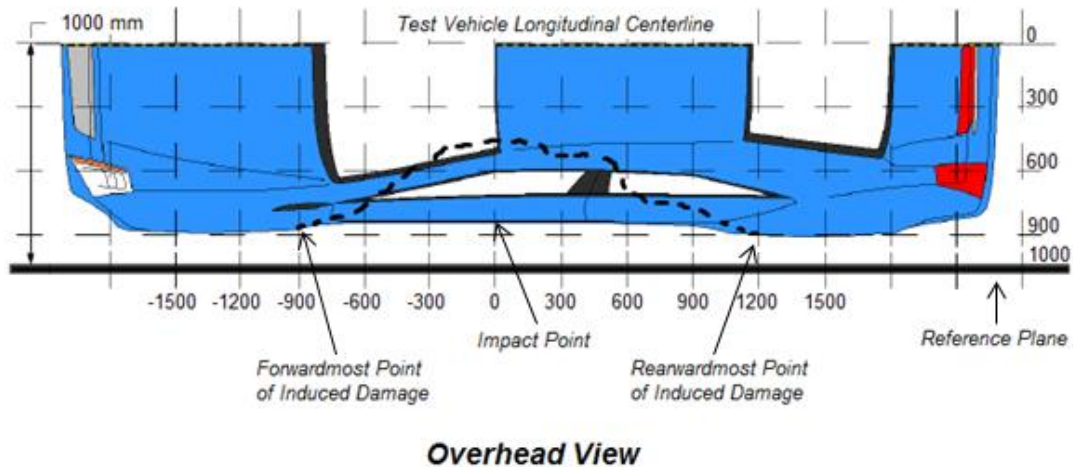
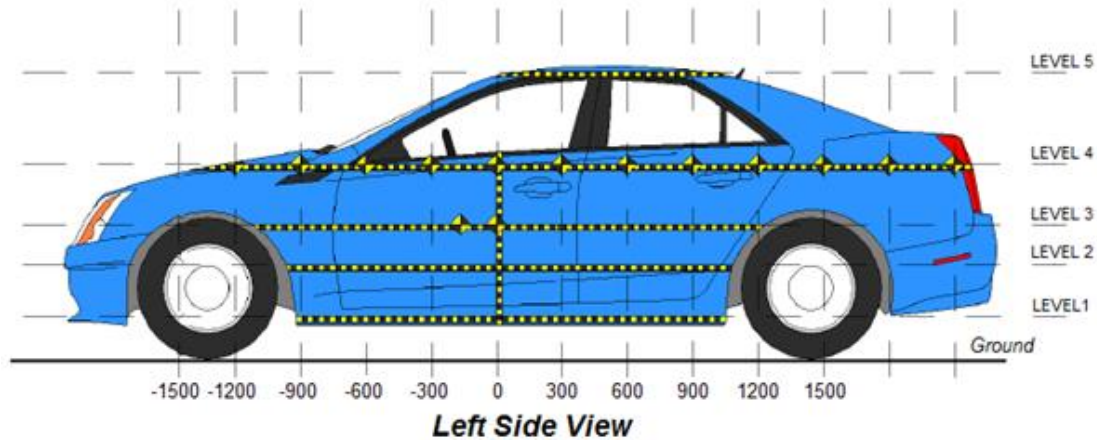
VEHICLE PRE- AND POST-TEST MEASUREMENT INFORMATION

Code	Description	Pre-Test	Post-Test	Difference
A	Vehicle Wheelbase	2689	2704	-15
B	Front Axle to FSOV	780	742	38
C	Rear Axle to RSOV	964	959	5
D	Total Length at Centerline	4433	4404	28
E	Front Bumper Thickness	175	175	0
F	Front Bumper Bottom to Ground	330	345	-15
G	Sill Height at Front Wheel Well	153	165	-12
H	Sill Height at Front Door Leading Edge	157	171	-14
I	Sill Height at B-Pillar	165	157	8
J1	Sill Height at Rear Wheel Well	165	167	-2
J2	Pinch Weld Height at Rear Wheel Well	163	159	4
K	Sill Height Aft of Rear Wheel Well	209	184	25
L	Rear Bumper Thickness	182	182	0
M	Rear Bumper Bottom to Ground	425	428	-3
N	Sill Height to Bottom of Front Window Sill	642	640	2
O	Front Door Leading Edge to Impact CL	872	828	43
P	Rear Door Trailing Edge to Impact CL	376	311	65
Q	Front Window Opening	365	337	28
R	Right Side Length	4317	4269	48
S	Left Side Length	4315	4308	7
T	Vehicle Width at B-Pillars	1733	1664	69

DATA SHEET NO. 14
TEST VEHICLE EXTERIOR CRUSH MEASUREMENTS

Test Vehicle: 2019 BMW 230i two door convertible
 Test Facility: Calspan

NHTSA No.: C20194100
 Test Date: 5/16/2019



MAXIMUM EXTERIOR CRUSH MEASUREMENTS

Level	Measurement Description	Units	Height Above Ground	Maximum Exterior Static Crush	Distance from Impact
1	Sill Top	mm	209	197	0
2	Occupant Hip Point	mm	487	239	0
3	Mid - Door	mm	654	280	0
4	Window Sill	mm	938	250	0
5	Window Top	mm	1348	52	0

NOTE: The above measurements should be taken along the vertical impact reference line. Vehicle measurements forward of the vertical impact reference line are negative.

DATA SHEET NO. 14
VEHICLE EXTERIOR CRUSH MEASUREMENTS (CONTINUED)

Test Vehicle: 2019 BMW 230i two door convertible
 Test Facility: Calspan

NHTSA No.: C20194100
 Test Date: 5/16/2019

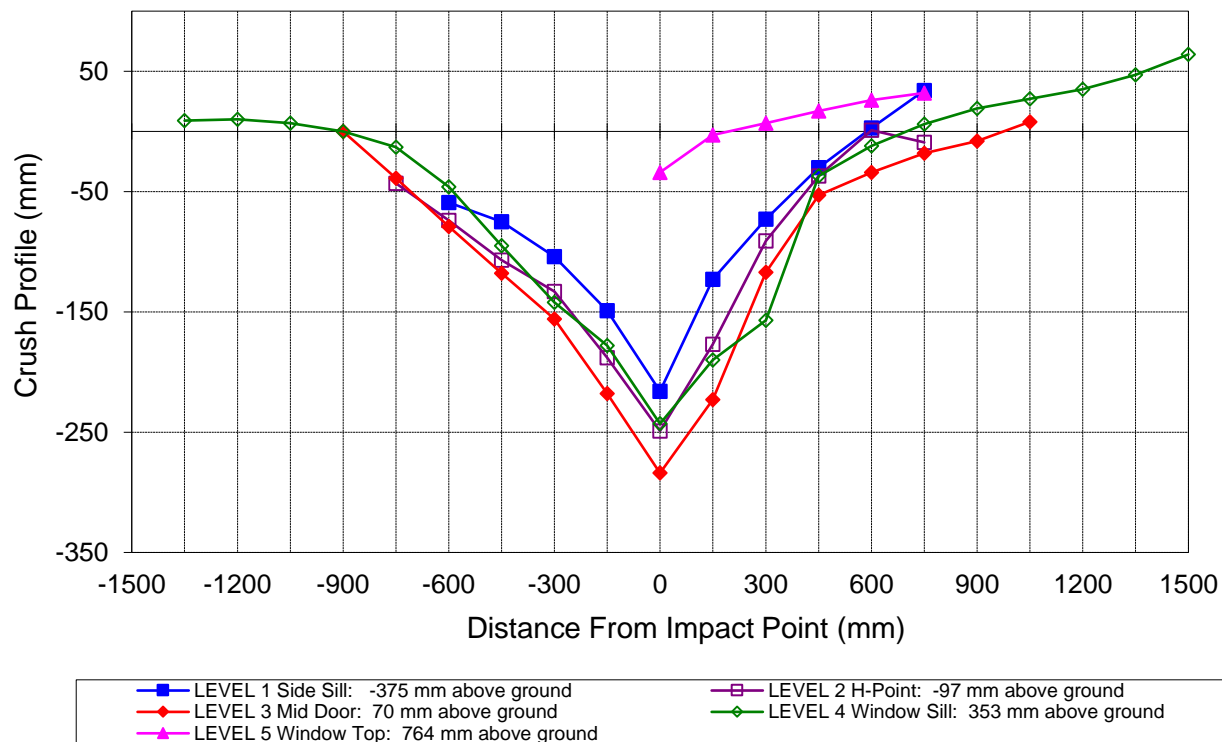
EXTERIOR CRUSH MEASUREMENTS AT EACH LEVEL

	Pre-Test					Post-Test					Difference				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
-1500															
-1350				-720					-761					41	
-1200				-743					-780					37	
-1050				-758					-789					31	
-900			-874	-768				-905	-789				31	21	
-750		-860	-875	-775			-849	-862	-778			-11	-13	3	
-600	-831	-859	-876	-786		-809	-812	-818	-750		-22	-47	-58	-36	
-450	-832	-857	-876	-796		-789	-773	-775	-708		-43	-84	-101	-88	
-300	-833	-855	-875	-805		-756	-740	-732	-665		-77	-115	-143	-140	
-150	-834	-853	-874	-811		-708	-679	-665	-631		-126	-174	-209	-180	
0	-834	-849	-873	-816	-594	-637	-610	-593	-566	-542	-197	-239	-280	-250	-52
150	-835	-846	-871	-818	-595	-728	-674	-647	-618	-564	-107	-172	-224	-200	-31
300	-836	-845	-867	-820	-592	-775	-755	-746	-704	-564	-61	-90	-121	-116	-28
450	-836	-853	-863	-819	-573	-813	-813	-801	-763	-551	-23	-40	-62	-56	-22
600	-836	-863	-863	-818	-518	-842	-857	-815	-782	-501	6	-6	-48	-36	-17
750	-836	-874	-872	-816	-452	-868	-853	-836	-793	-438	32	-21	-36	-23	-14
900			-885	-813				-854	-799				-31	-14	
1050			-885	-808				-865	-798				-20	-10	
1200				-801					-794					-7	
1350				-791					-797					6	
1500				-780					-791					11	

DATA SHEET NO. 14
TEST VEHICLE EXTERIOR CRUSH MEASUREMENTS (CONTINUED)

Test Vehicle: 2019 BMW 230i two door convertible
 Test Facility: Calspan

NHTSA No.: C20194100
 Test Date: 5/16/2019

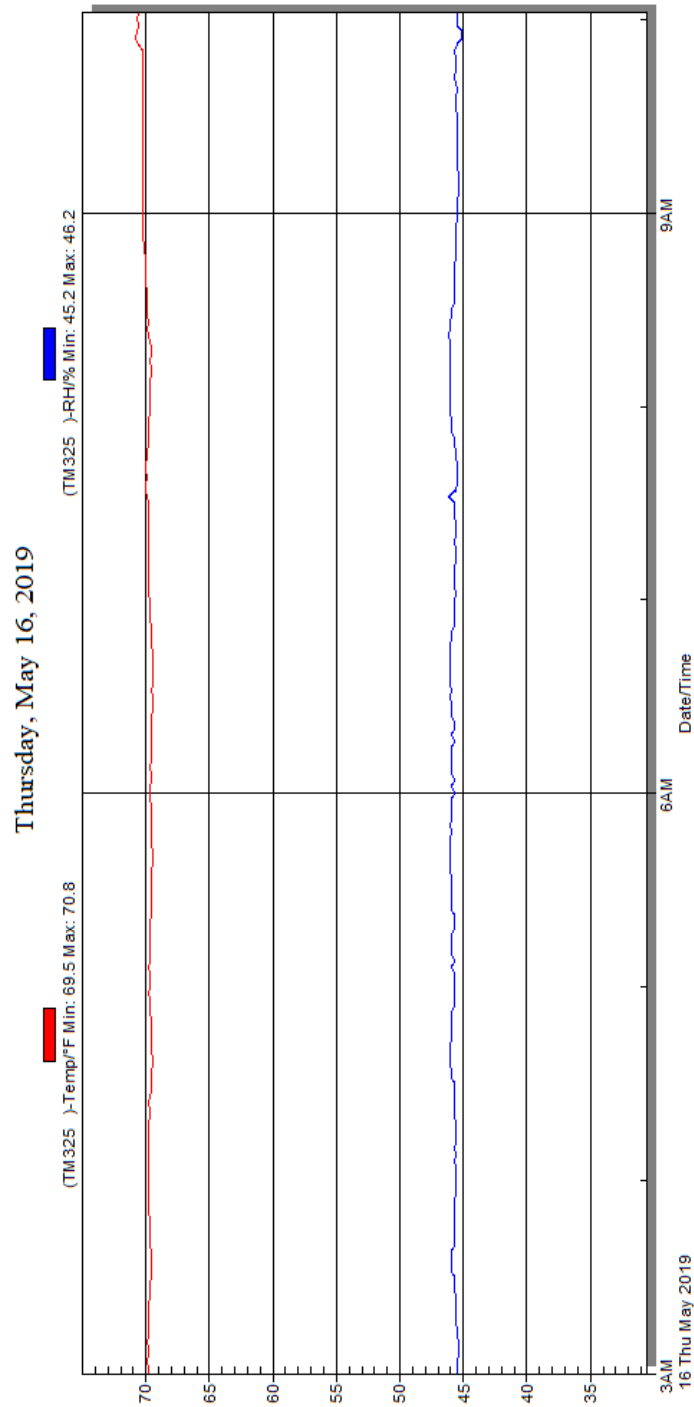


Vehicle Exterior Crush Measurements - Visual Representation

DATA SHEET NO. 16
DUMMY / VEHICLE TEMPERATURE AND HUMIDITY STABILIZATION DATA

Test Vehicle: 2019 BMW 230i two door convertible
 Test Facility: Calspan

NHTSA No.: C20194100
 Test Date: 5/16/2019



Temperature and Humidity Stabilization Chart / Data for Dummies and Test Vehicle

APPENDIX I
PHOTOGRAPHS

TABLE OF PHOTOGRAPHS

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2	Post Test Frontal View of Test Vehicle	I-3
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8	Pre-Test Left $\frac{3}{4}$ Rear View of Vehicle and Pole	I-6
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14	Post-Test Close-Up of Dummy with Door Closed (Impact Side)	I-9
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23	Post-Test $\frac{3}{4}$ Rear View of Impact Zone	I-14
24	Post-Test Close-Up View of Impact Point Target	I-14
25	Close-Up View of Vehicle's Certification Label	I-15
26	Close-Up View of Vehicle's Tire Placard Label	I-15



Figure A-1: Pre-Test Frontal View of Test Vehicle



Figure A-2: Post-Test Frontal View of Test Vehicle



Figure A-3: Pre-Test Rear View of Test Vehicle



Figure A-4: Post-Test Rear View of Test Vehicle



Figure A-5: Pre-Test Impacted Side View of Test Vehicle

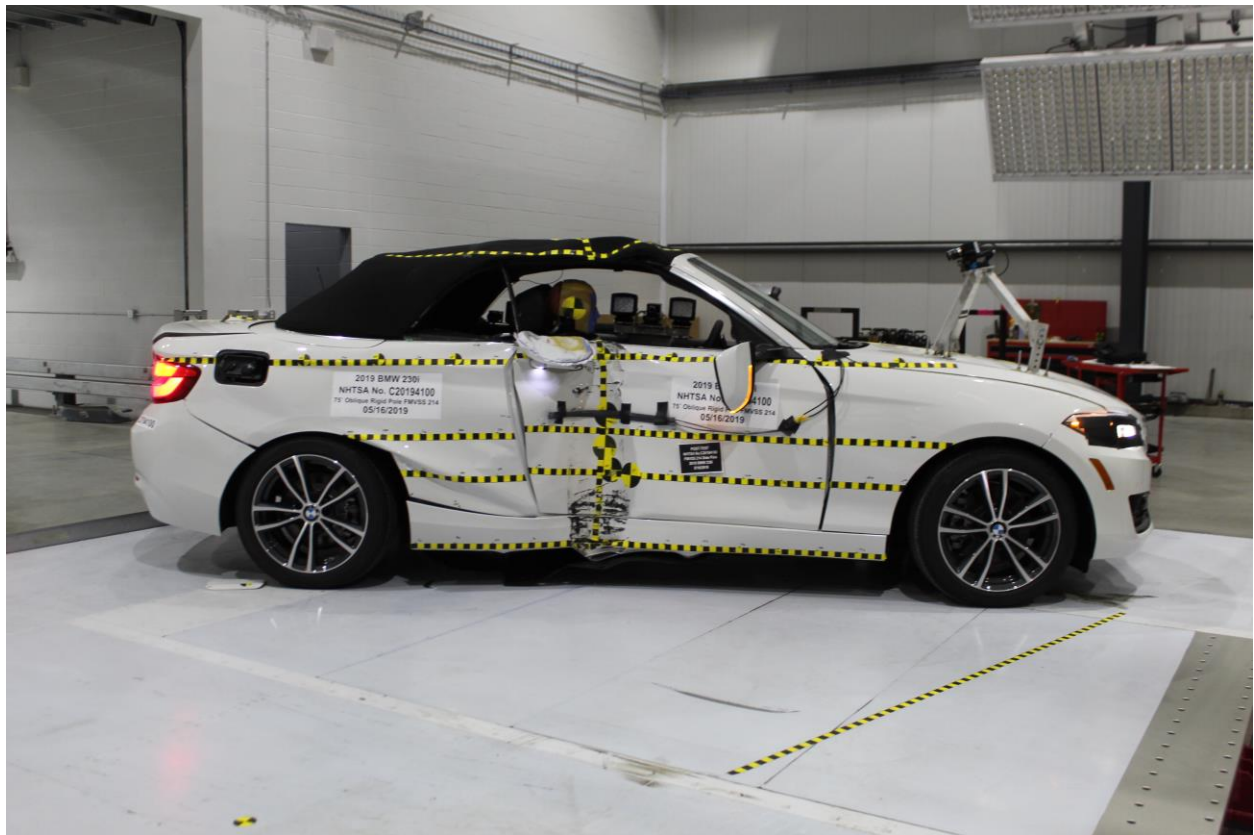


Figure A-6: Post-Test Impacted Side View of Test Vehicle

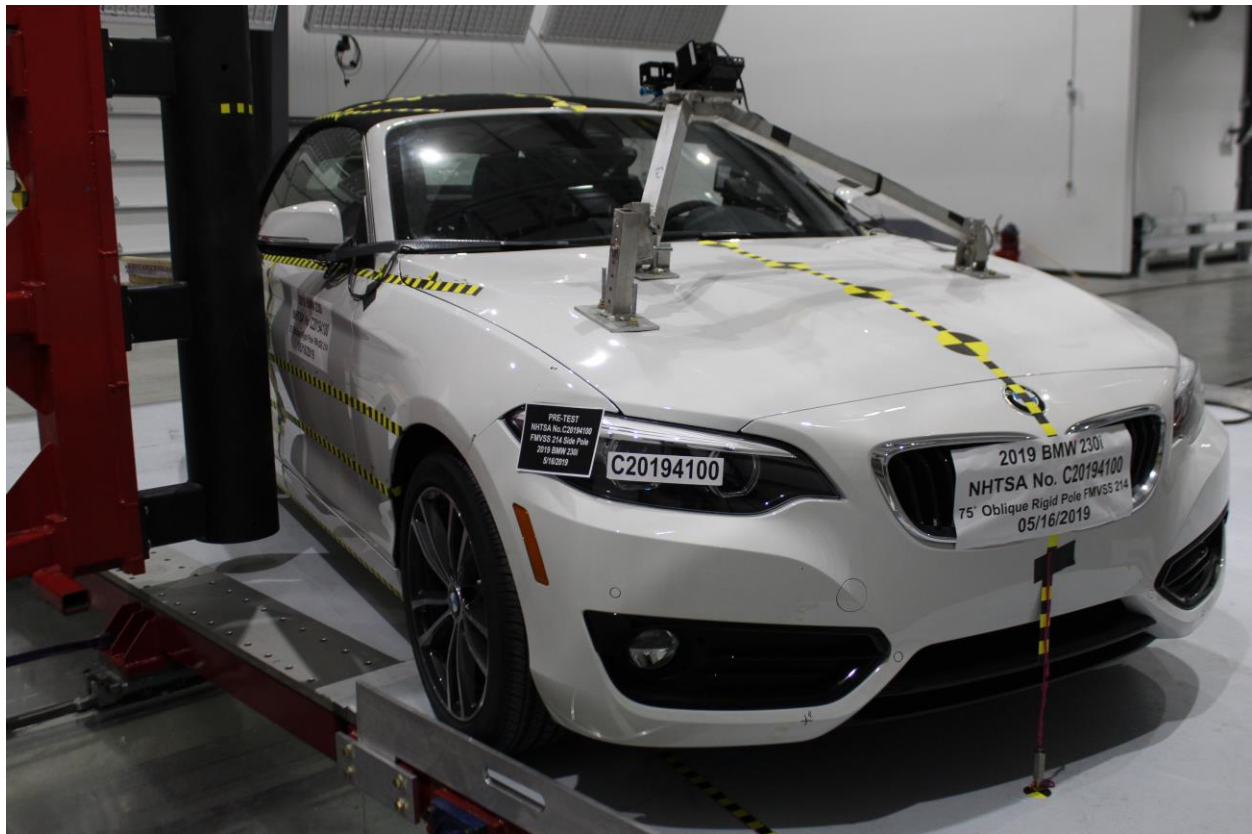


Figure A-7: Pre-Test Left $\frac{3}{4}$ Front View of Vehicle and Pole



Figure A-8: Pre-Test Left $\frac{3}{4}$ Rear View of Vehicle and Pole

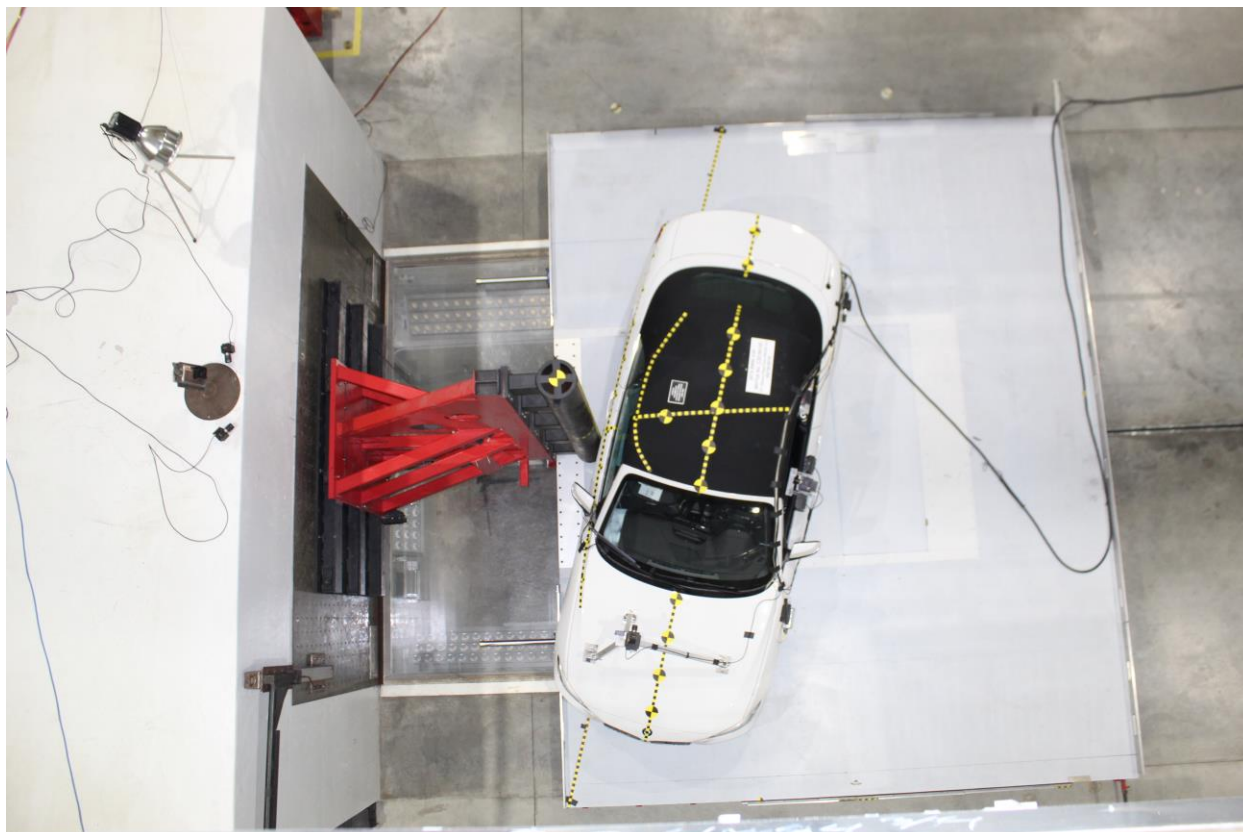


Figure A-9: Pre-Test Overhead View of Test Vehicle

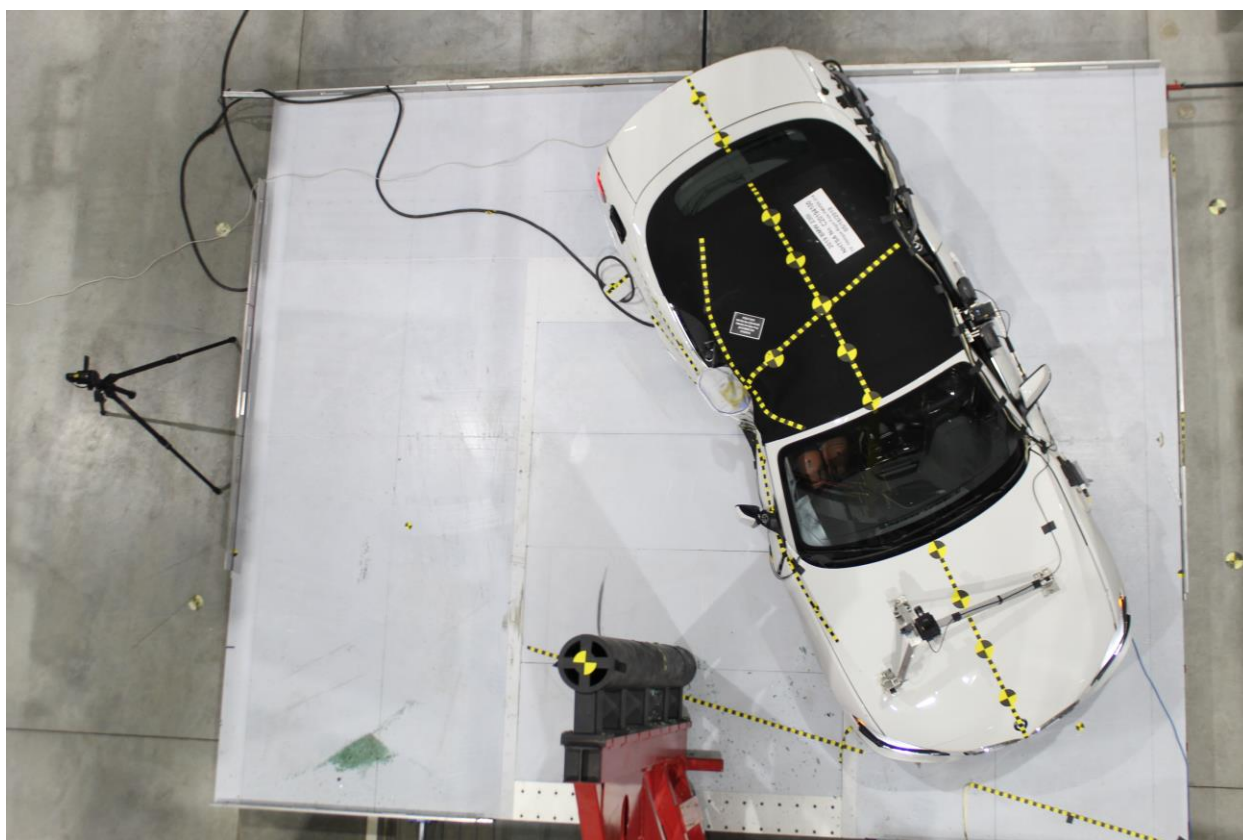


Figure A-10: Post-Test Overhead View of Test Vehicle



Figure A-11: Pre-Test Dummy Through Opposite Window

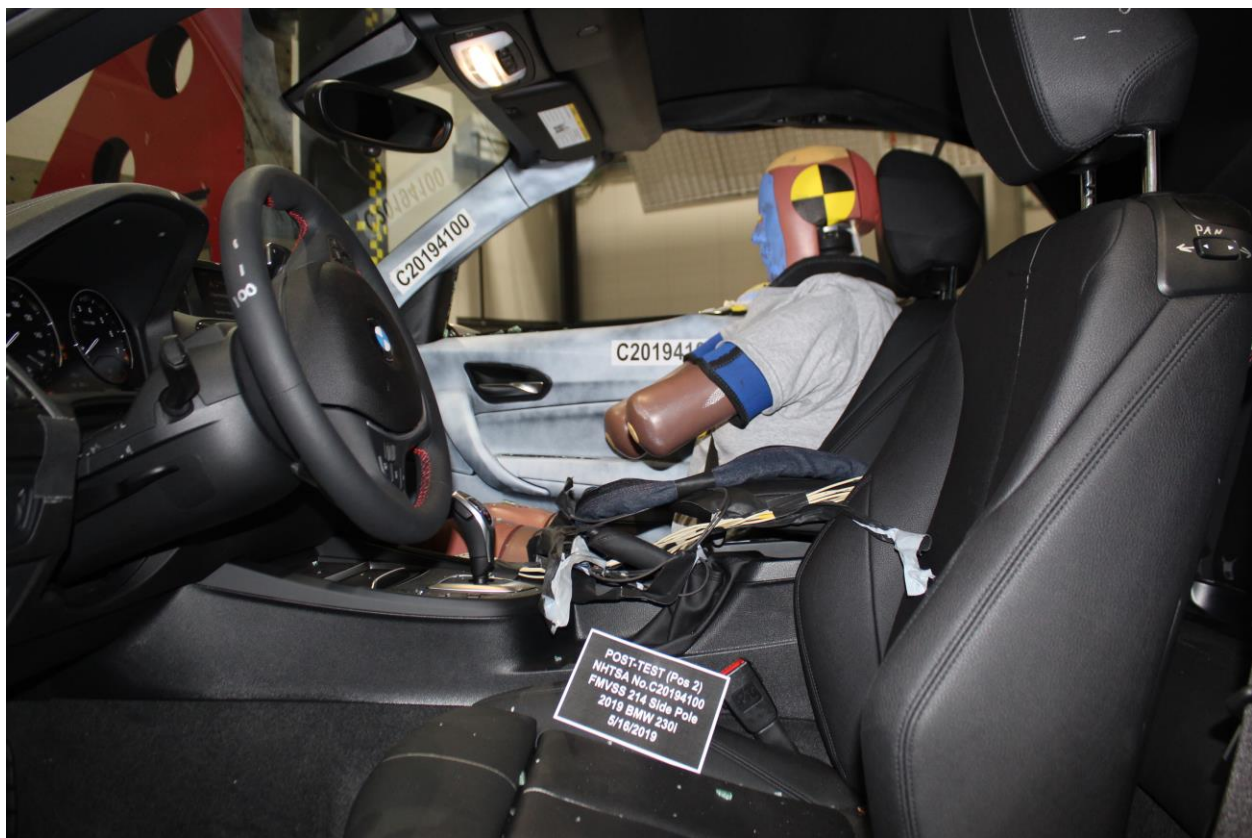


Figure A-12: Post-Test Dummy Through Opposite Window



Figure A-13: Pre-Test Close-Up of Dummy with Door Closed (Impact Side)



Figure A-14: Post-Test Close-Up of Dummy with Door Closed (Impact Side)



Figure A-15: Pre-Test Dummy with Door Open



Figure A-16: Pre-Test Dummy Shoulder and Door Top View

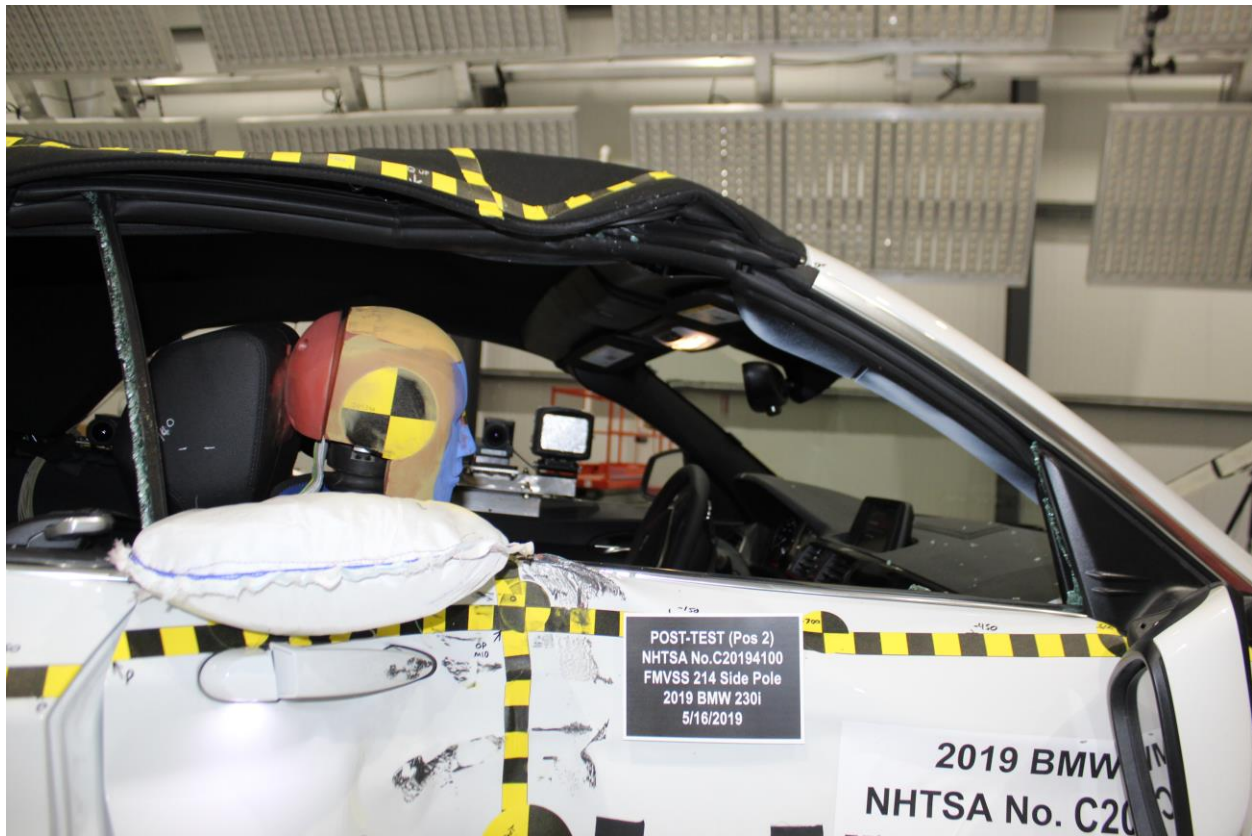


Figure A-17: Post-Test Dummy Shoulder and Door Top View



Figure A-18: Pre-Test Interior of Front Door Closed (through opposite window)



Figure A-19: Post-Test Interior of Front Door Showing Dummy Impact Locations



Figure A-20: Impact Event (struck side)



Figure A-21: Post-Test Impact Zone Close-Up View

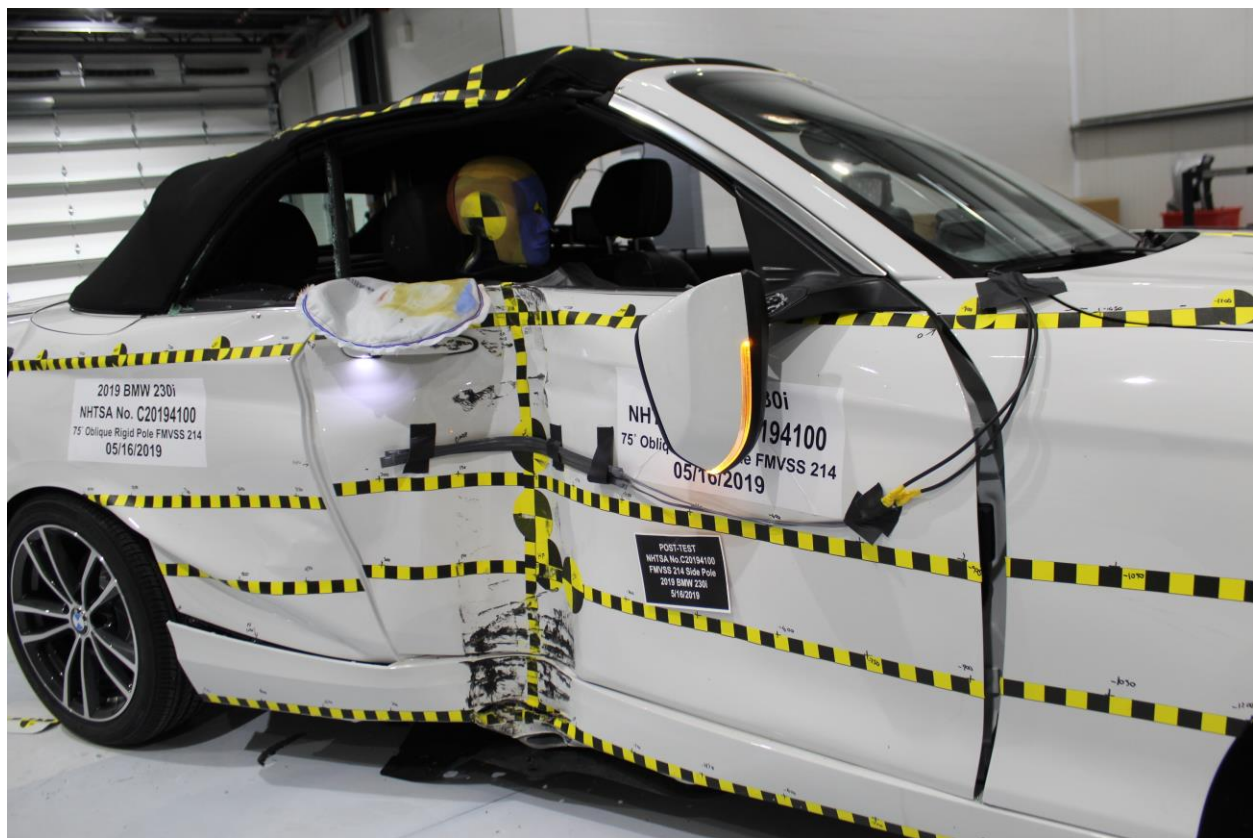


Figure A-22: Post-Test ¾ Front View of Impact Zone



Figure A-23: Post-Test ¾ Rear View of Impact Zone



Figure A-24: Close-Up View of Impact Point Target



Figure A-25: Close-Up View of Vehicle's Certification Label

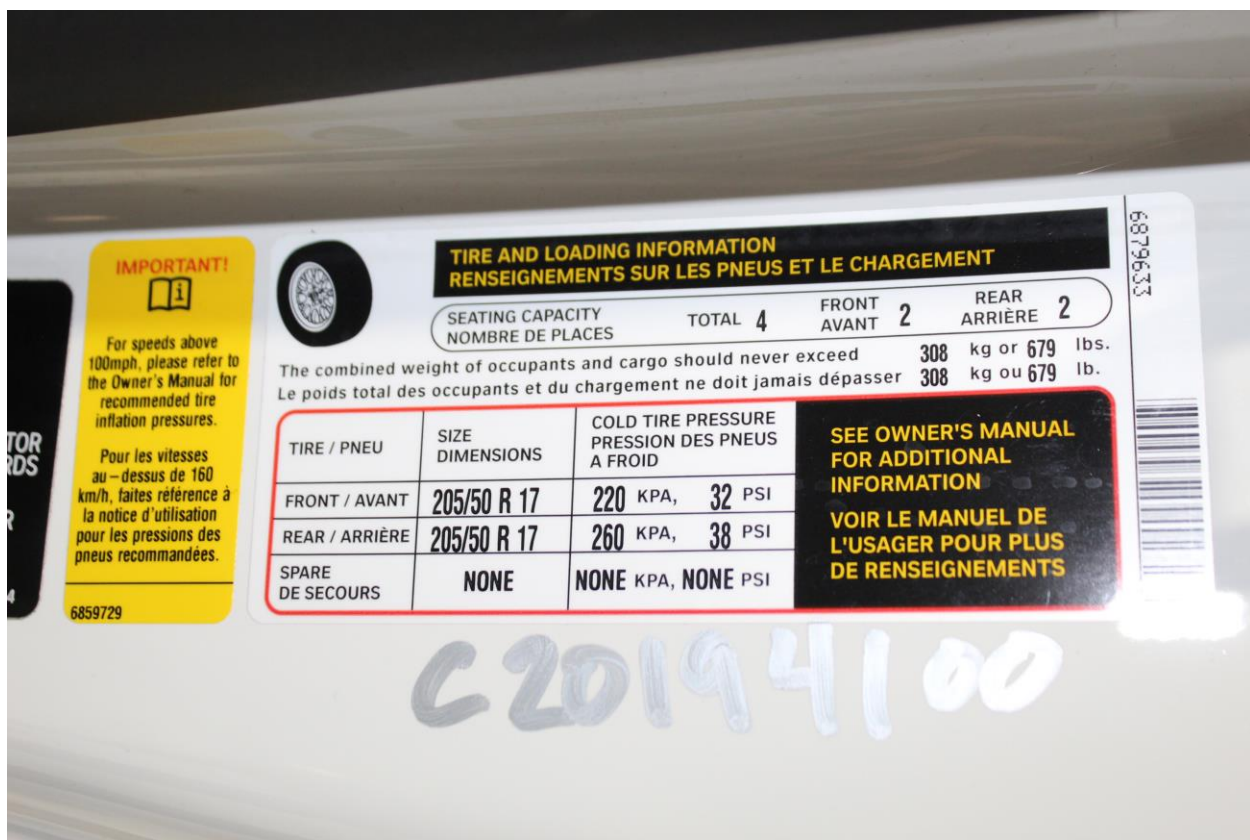


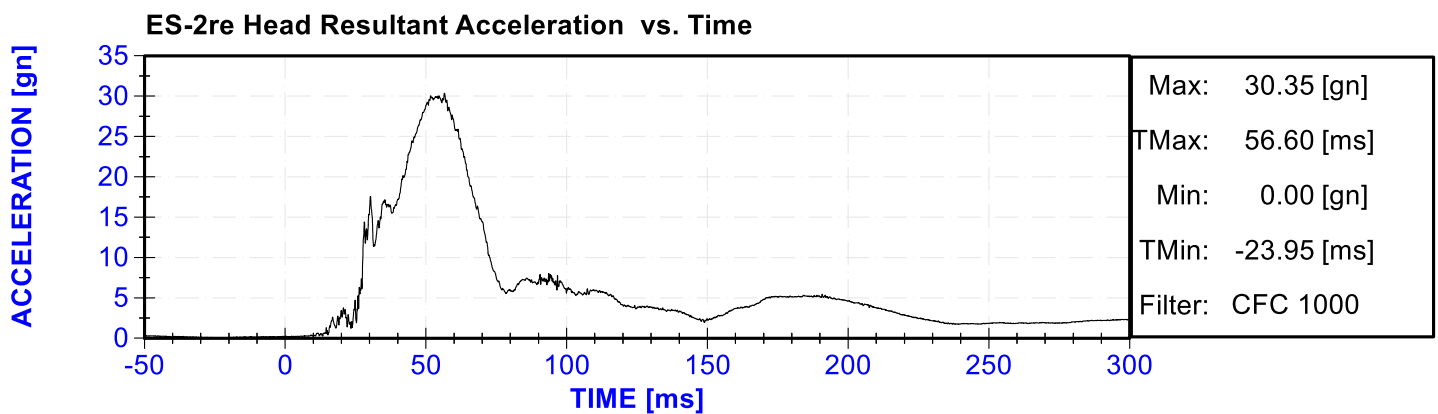
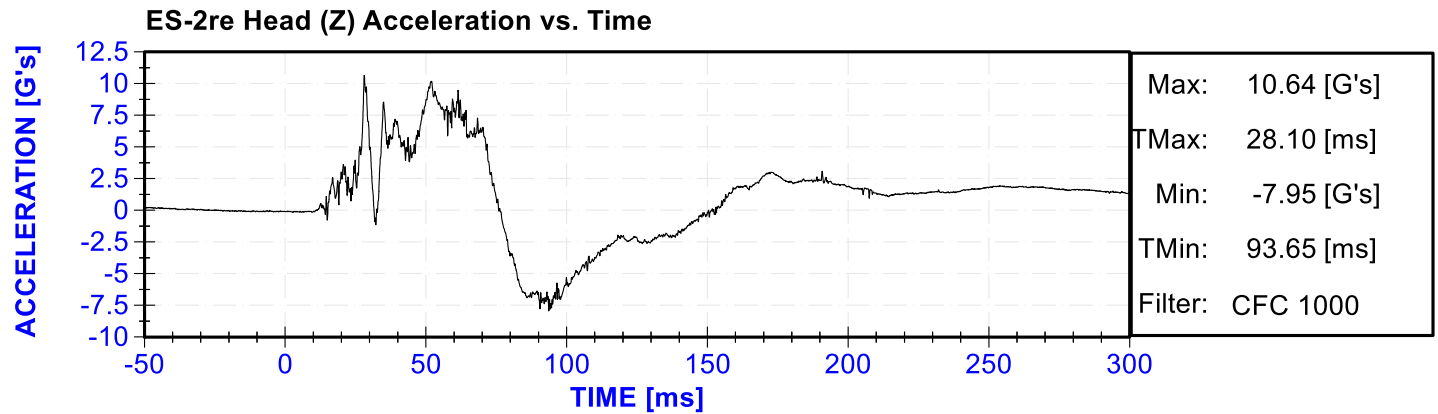
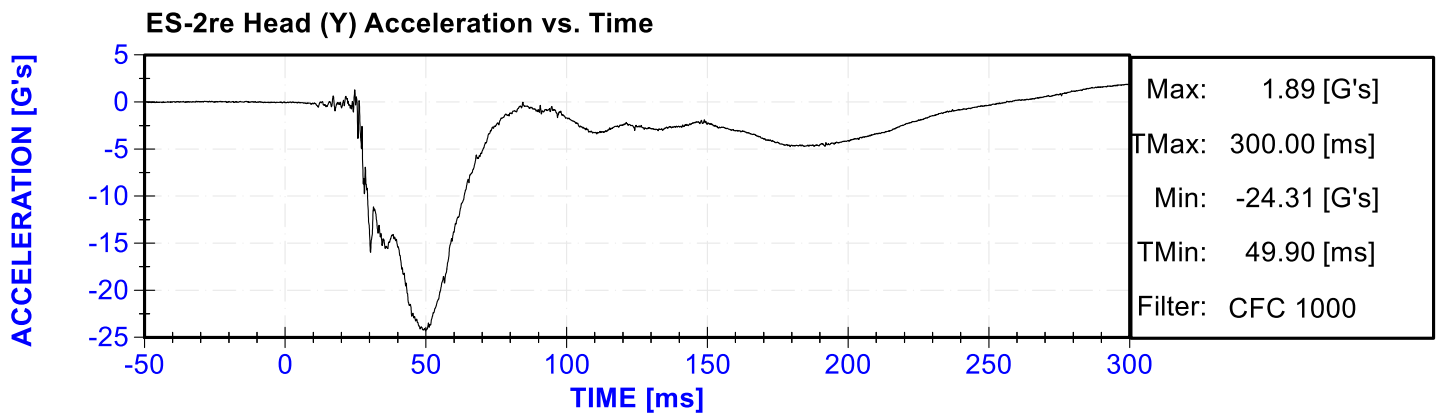
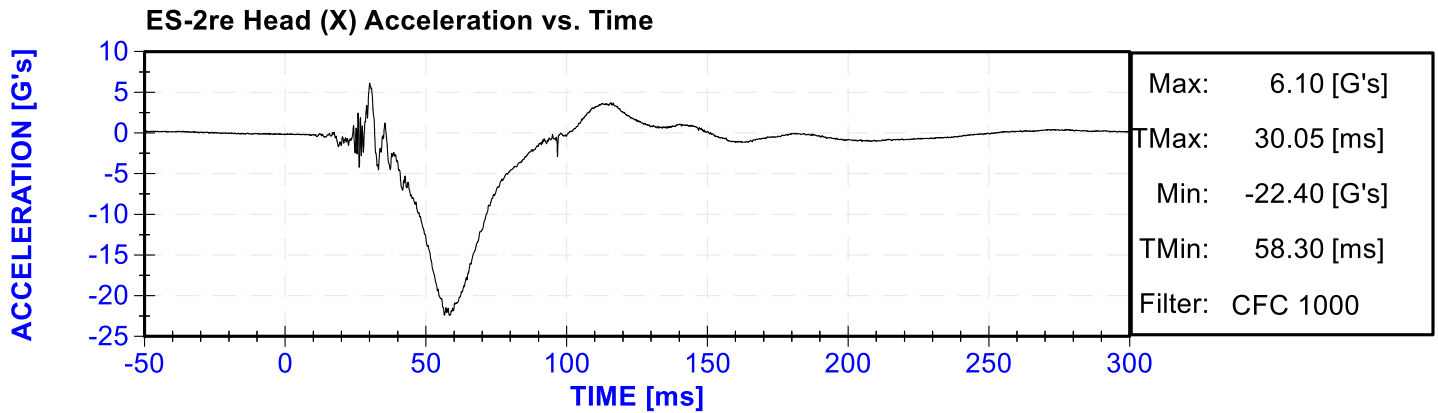
Figure A-26: Close-Up View of Vehicle's Tire Placard Label

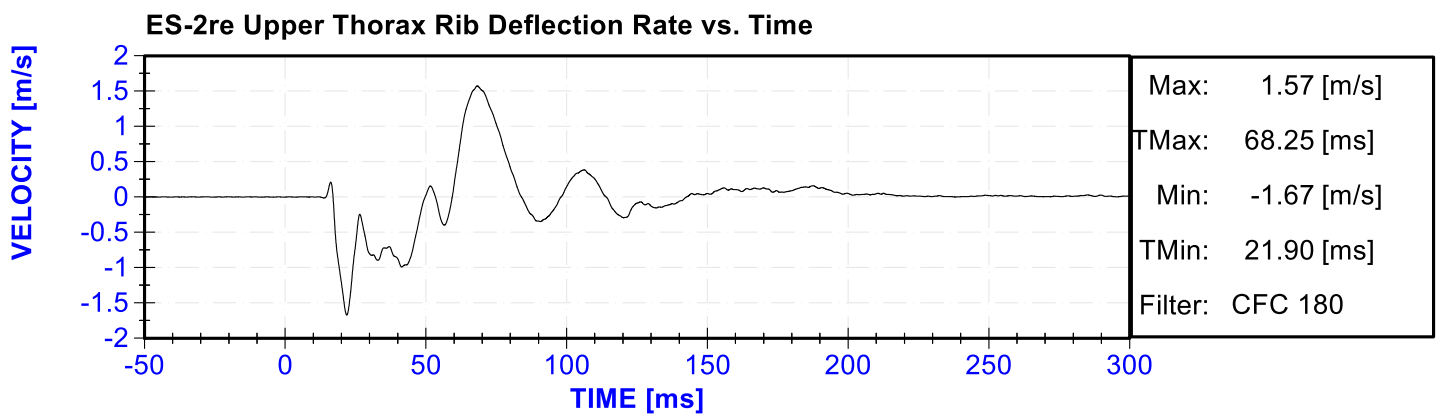
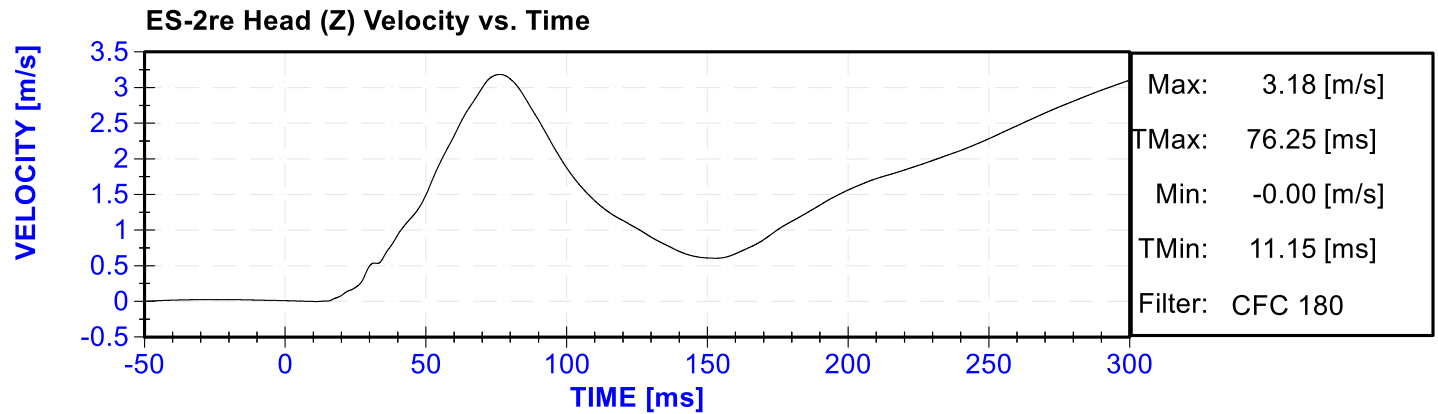
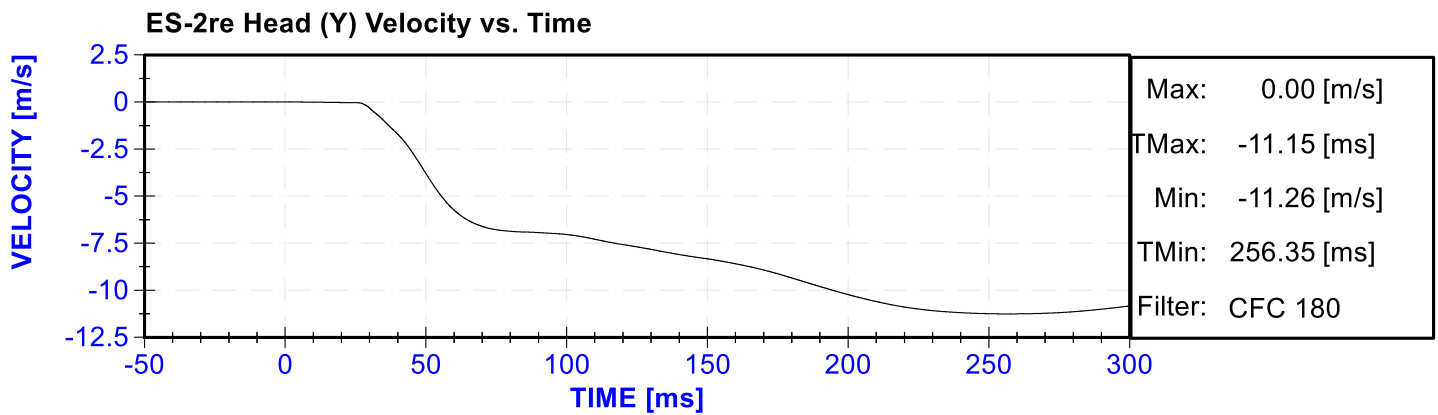
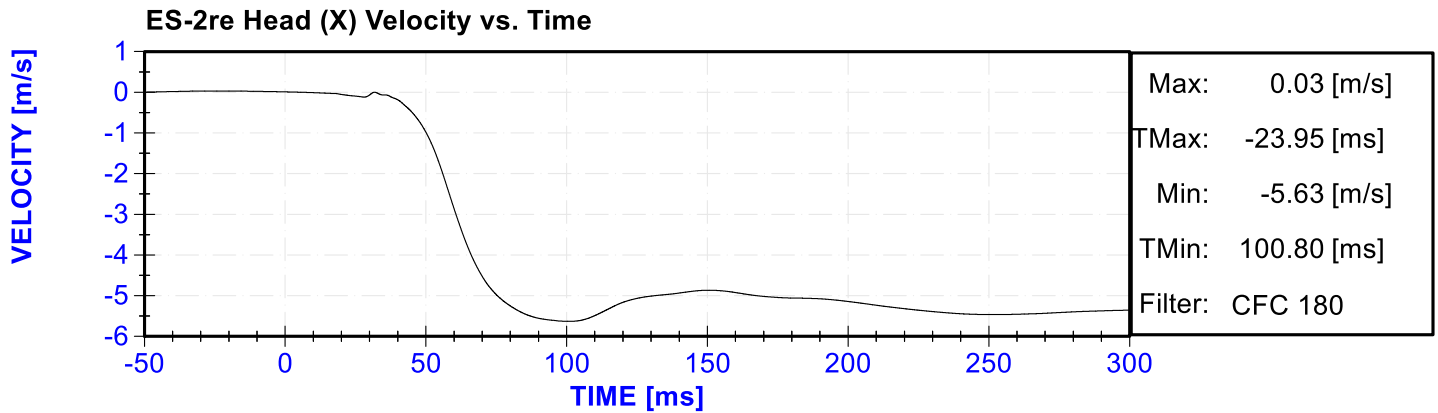
APPENDIX II

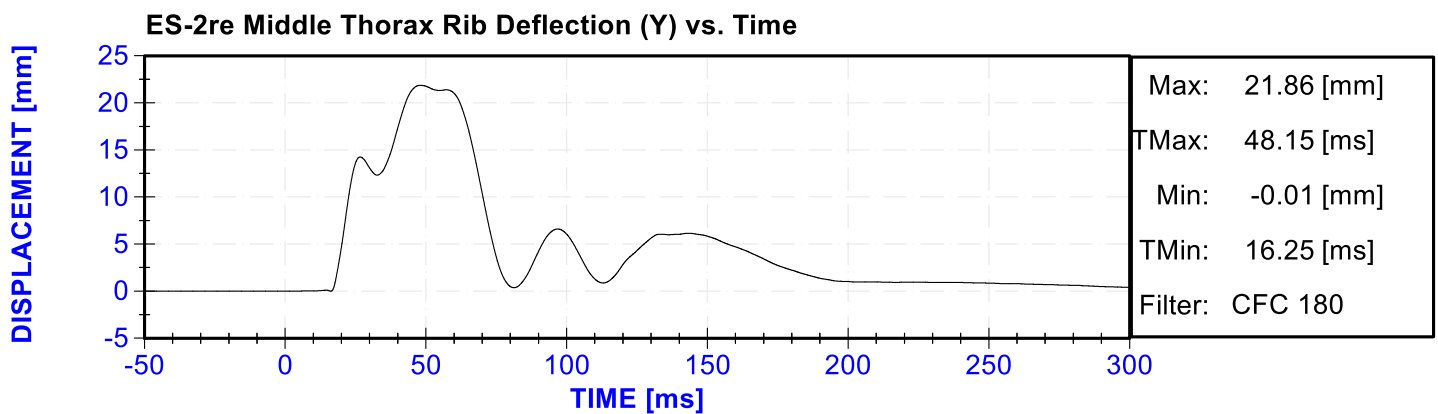
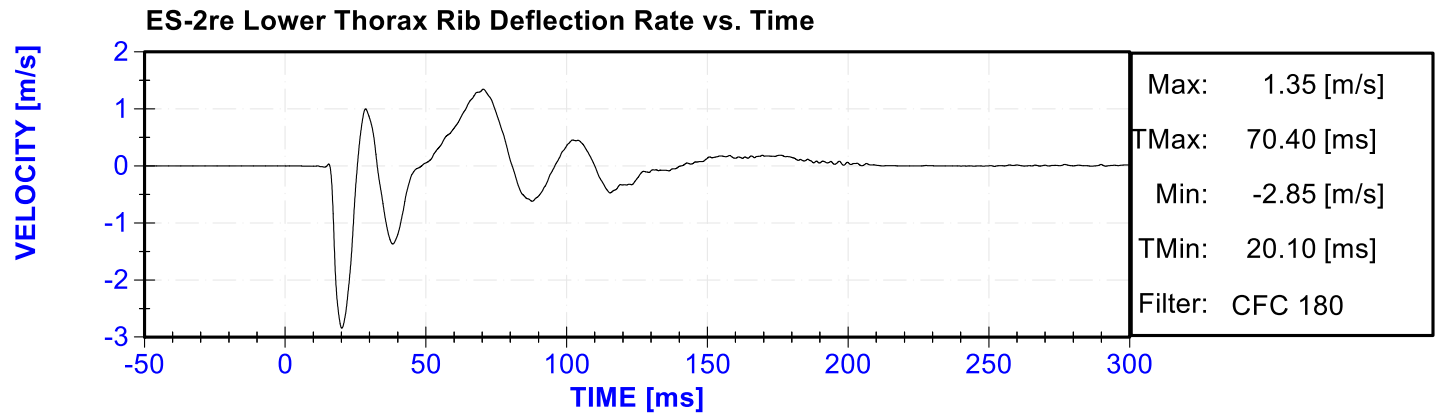
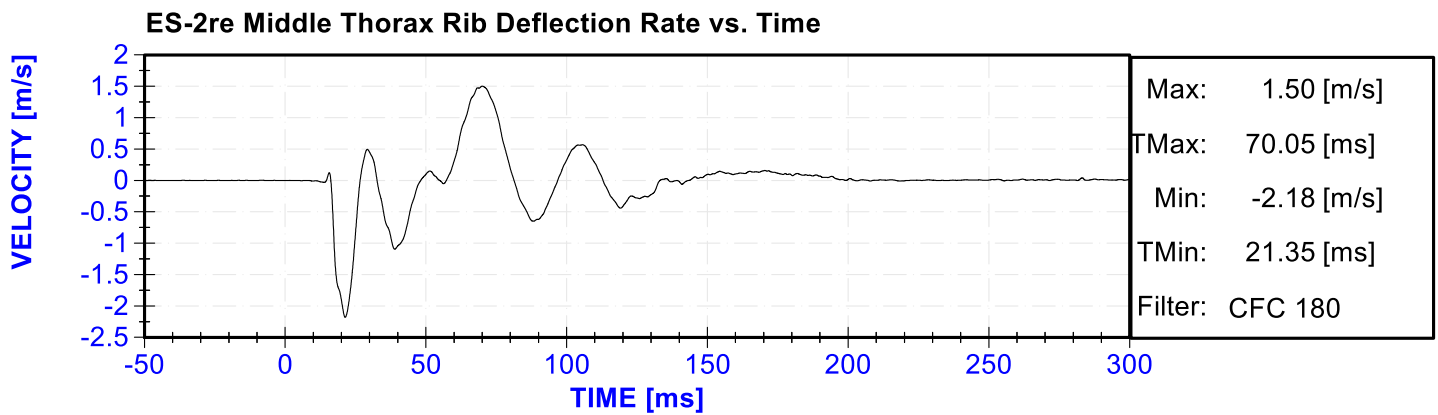
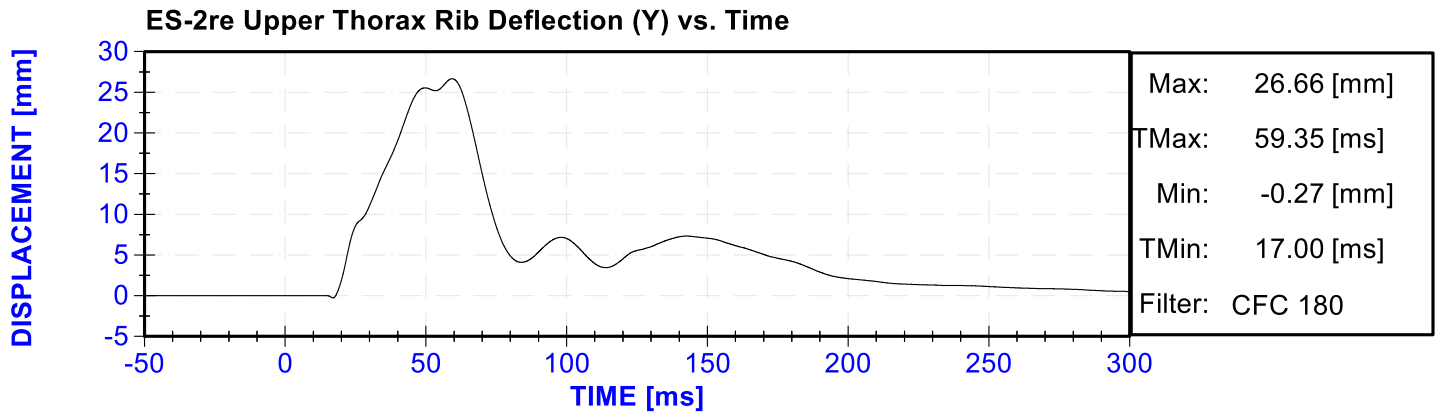
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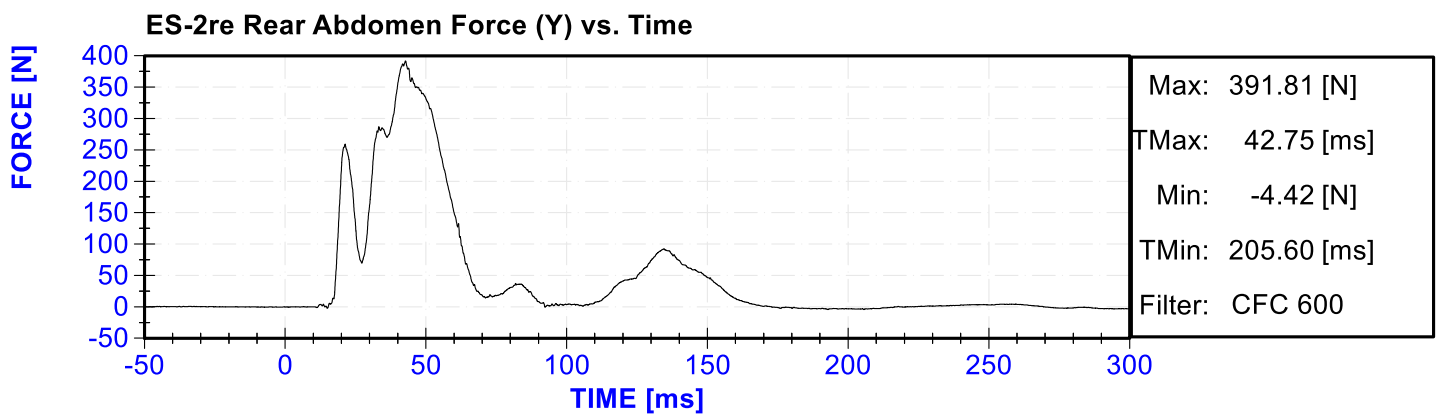
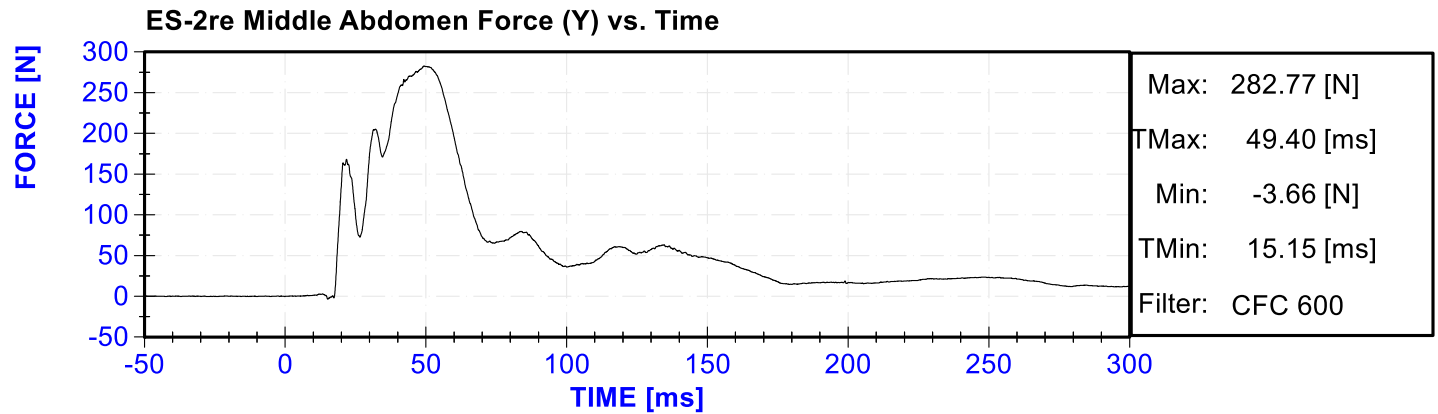
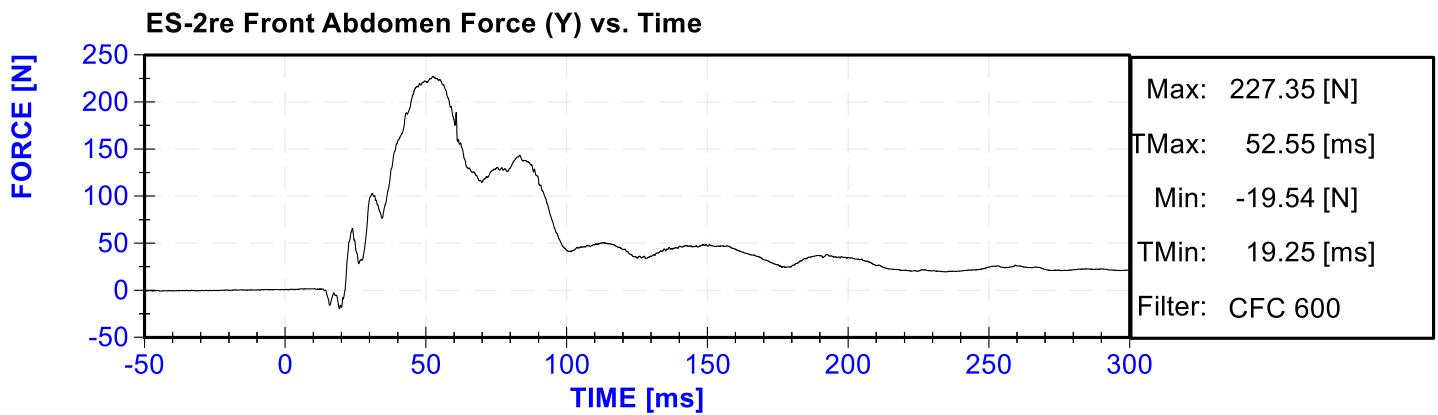
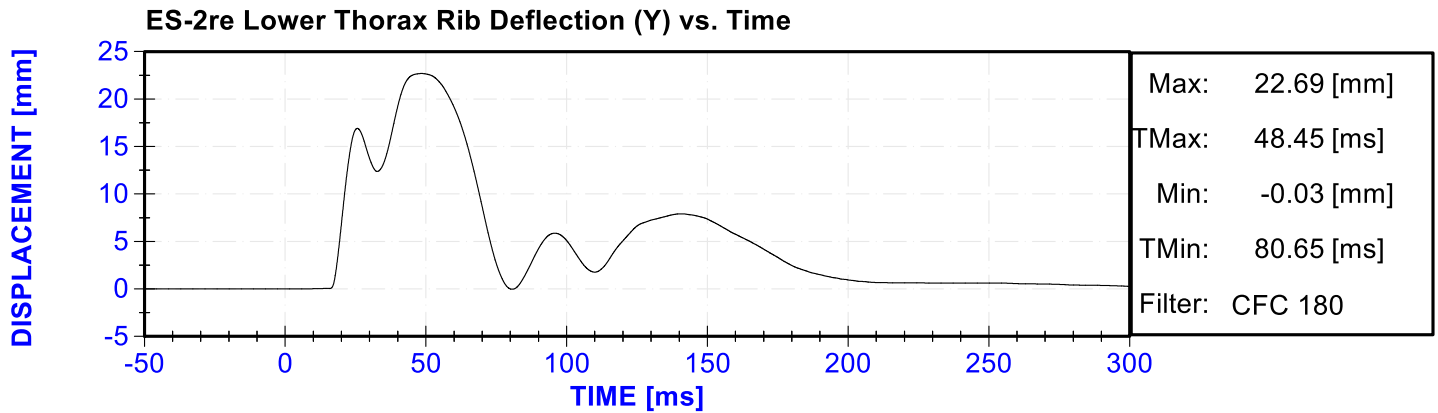
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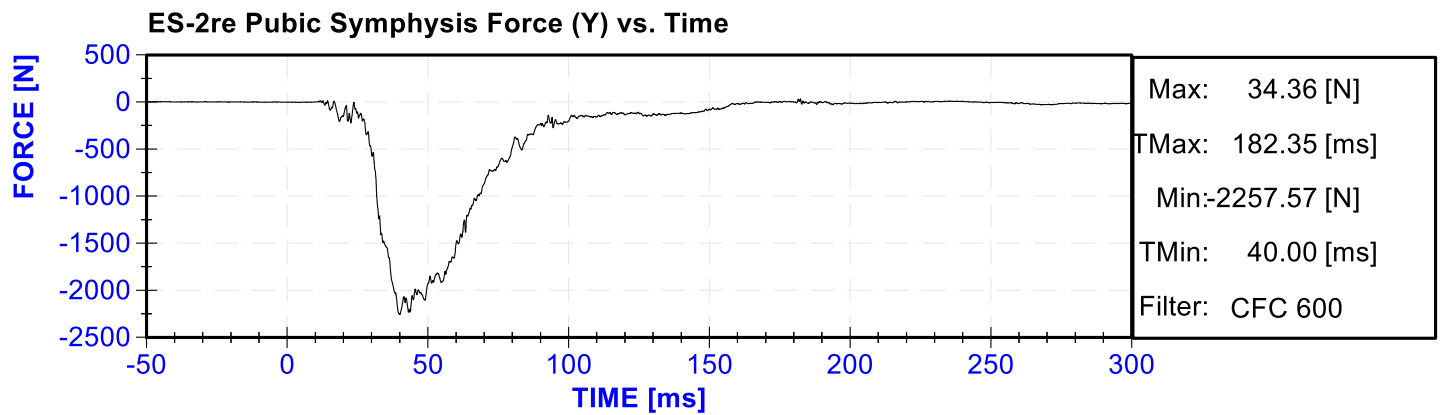
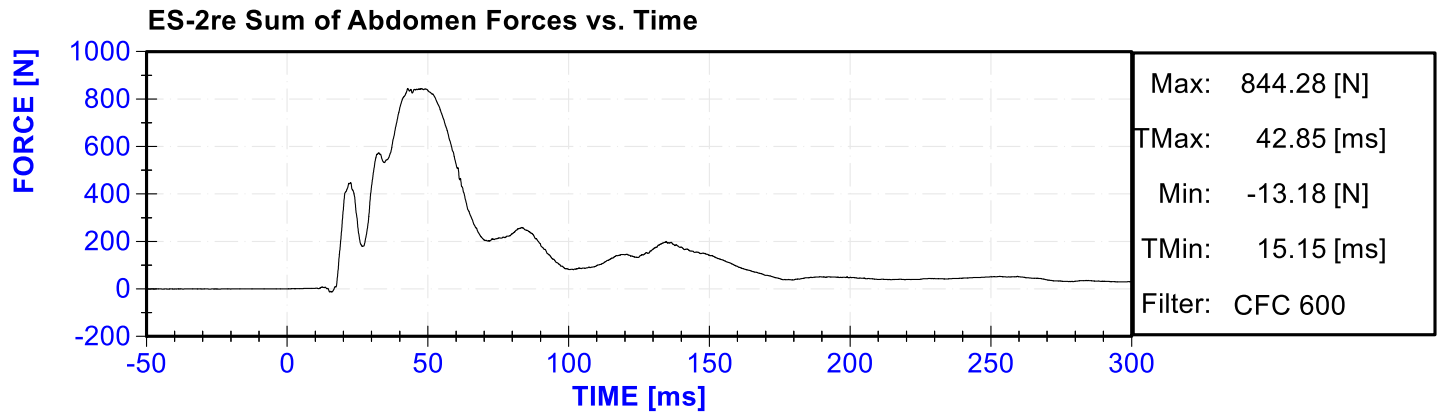
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Plot 1	ES-2re Head (X) Acceleration vs. Time	II-3
Plot 2	ES-2re Head (Y) Acceleration vs. Time	II-3
Plot 3	ES-2re Head (Z) Acceleration vs. Time	II-3
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Plot 5	ES-2re Head (X) Velocity vs. Time	II-4
Plot 6	ES-2re Head (Y) Velocity vs. Time	II-4
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Plot 8	ES-2re Upper Thorax Rib Deflection Rate vs. Time	II-4
Plot 9	ES-2re Upper Thorax Rib Deflection (Y) vs. Time	II-5
Plot 10	ES-2re Middle Thorax Rib Deflection Rate vs. Time	II-5
Plot 11	ES-2re Lower Thorax Rib Deflection Rate vs. Time	II-5
Plot 12	ES-2re Middle Thorax Rib Deflection (Y) vs. Time	II-5
Plot 13	ES-2re Lower Thorax Rib Deflection (Y) vs. Time	II-6
Plot 14	ES-2re Front Abdomen Force (Y) vs. Time	II-6
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Plot 17	ES-2re Sum of Abdomen Forces vs. Time	II-7
Plot 18	ES-2re Pubic Symphysis Force (Y) vs. Time	II-7









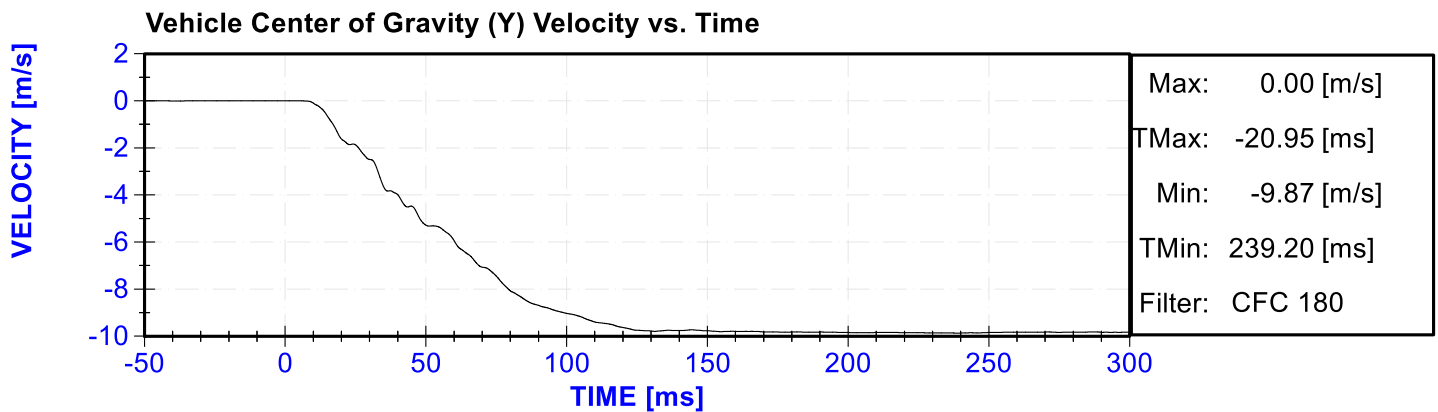
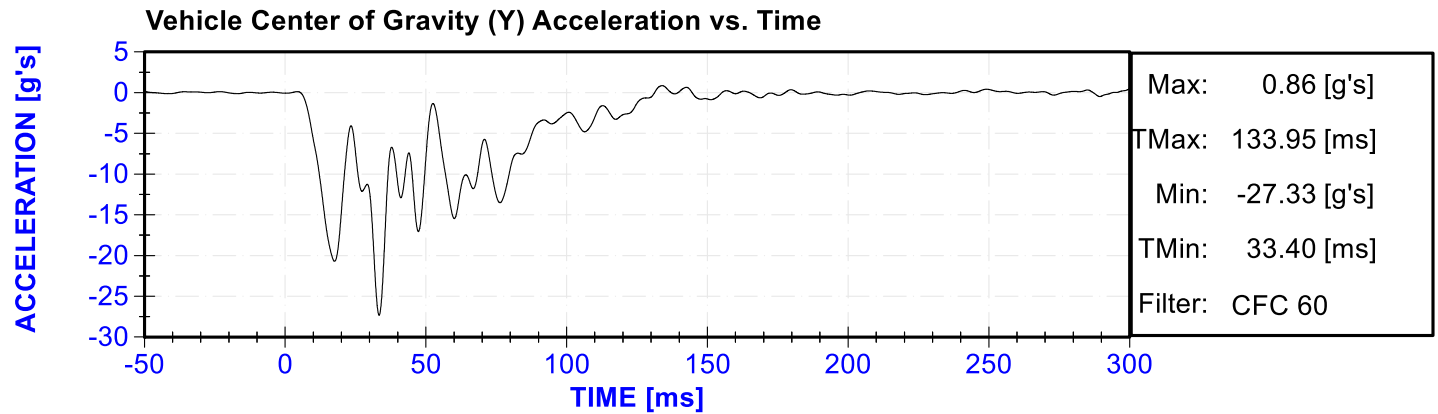
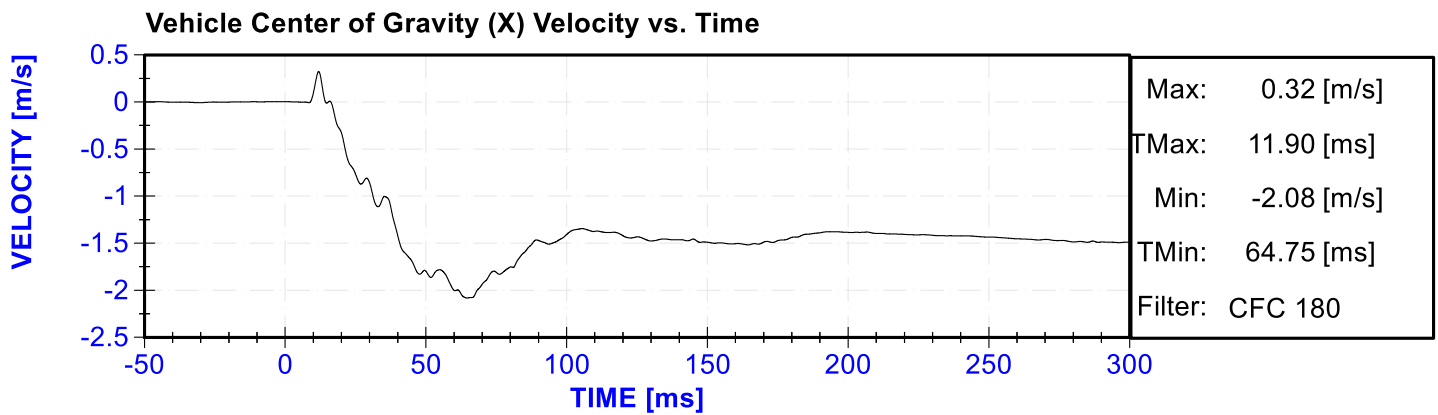
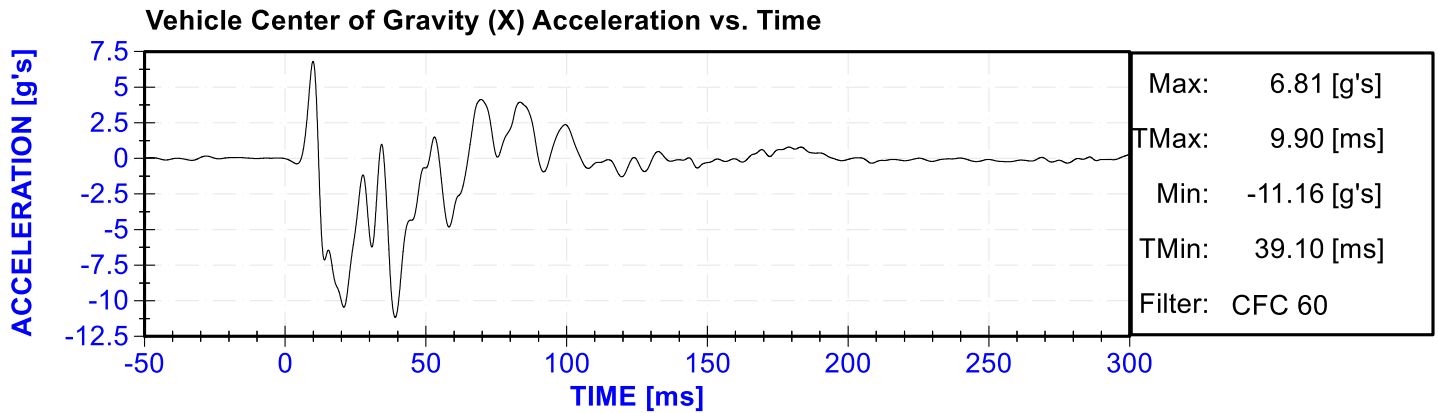


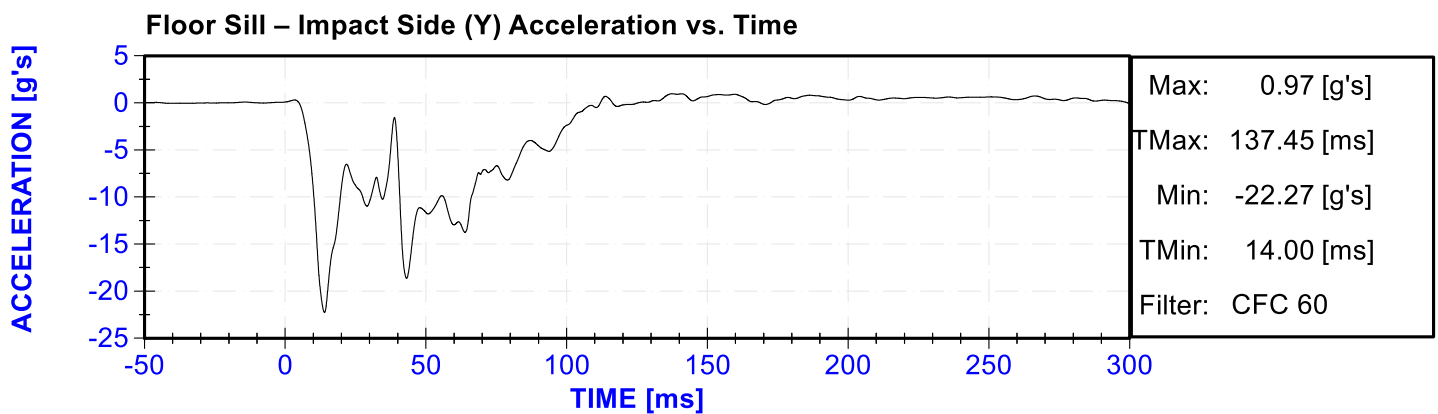
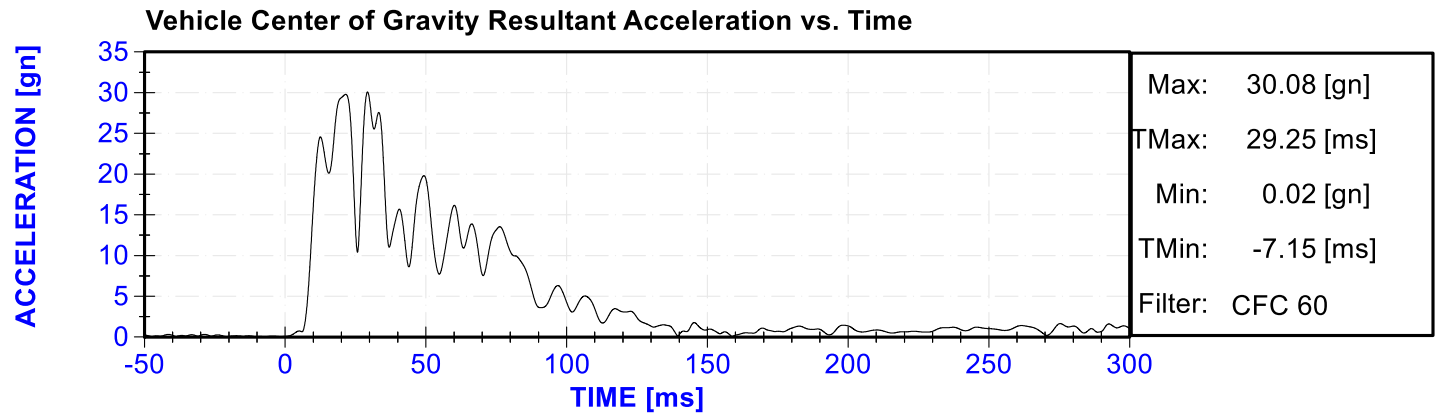
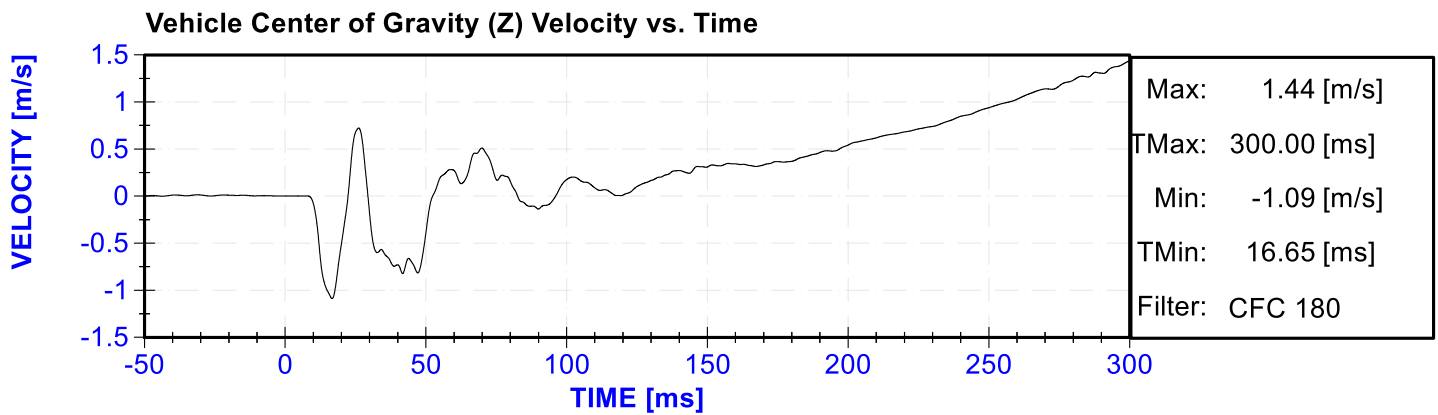
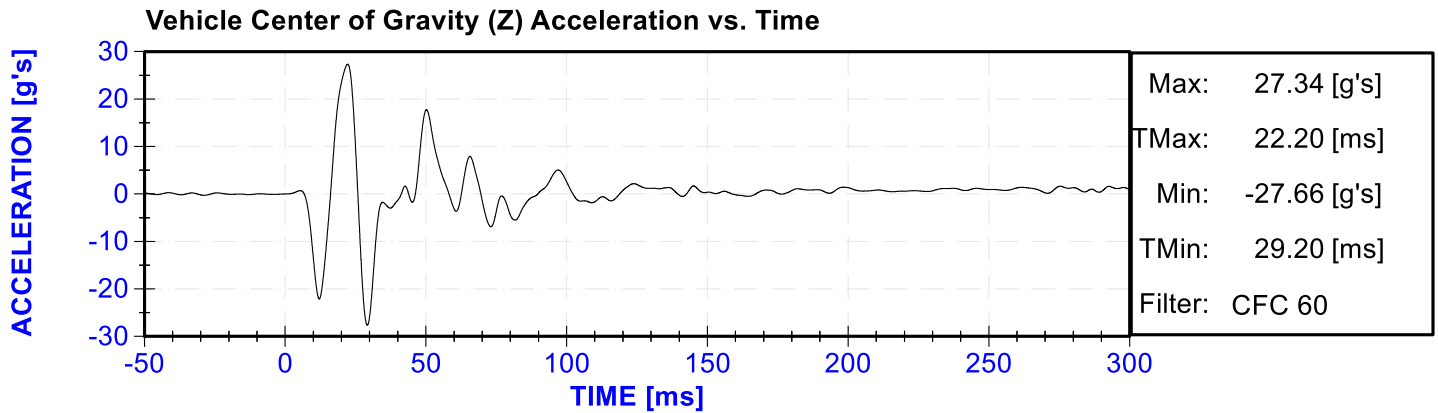
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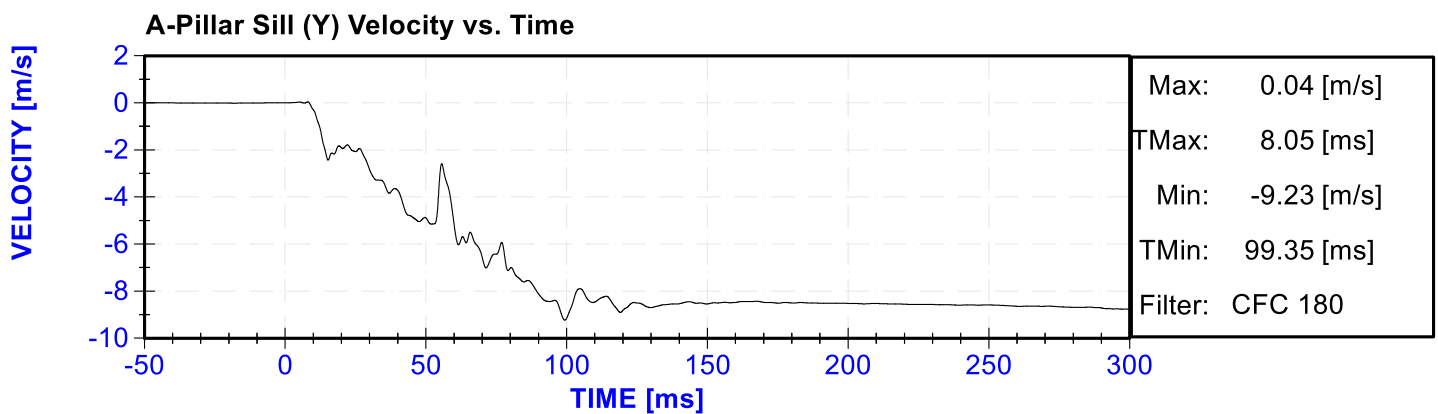
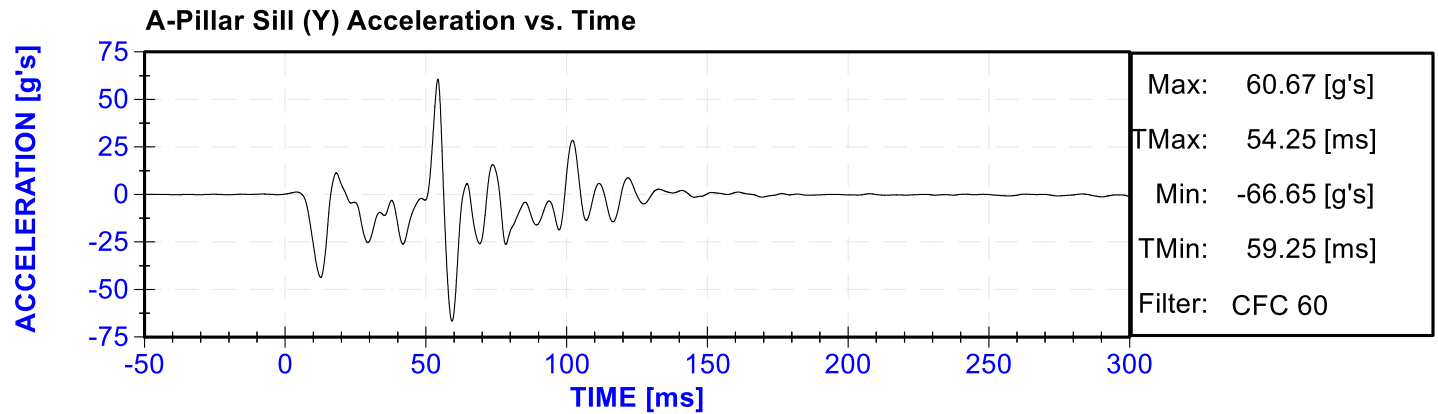
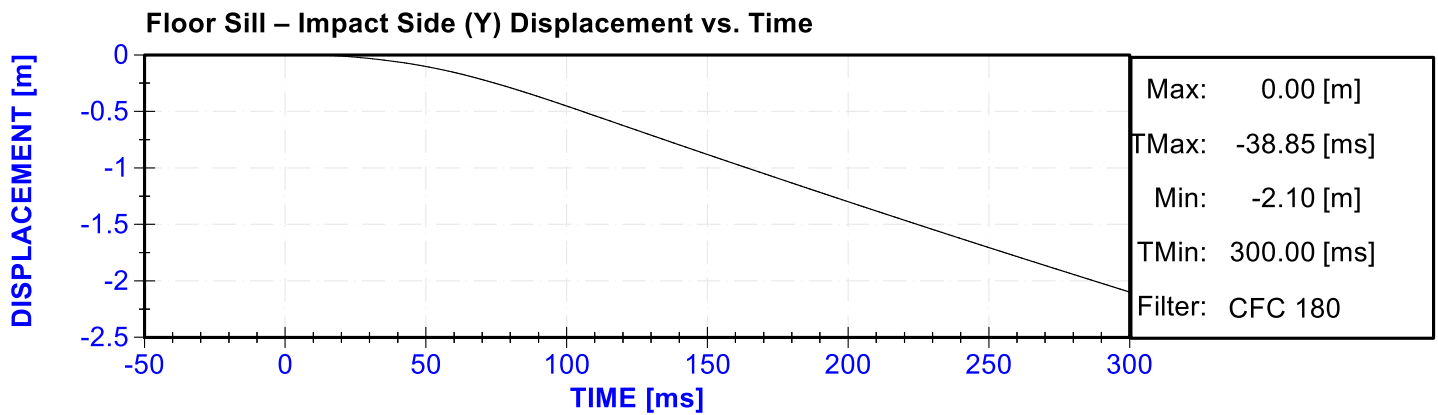
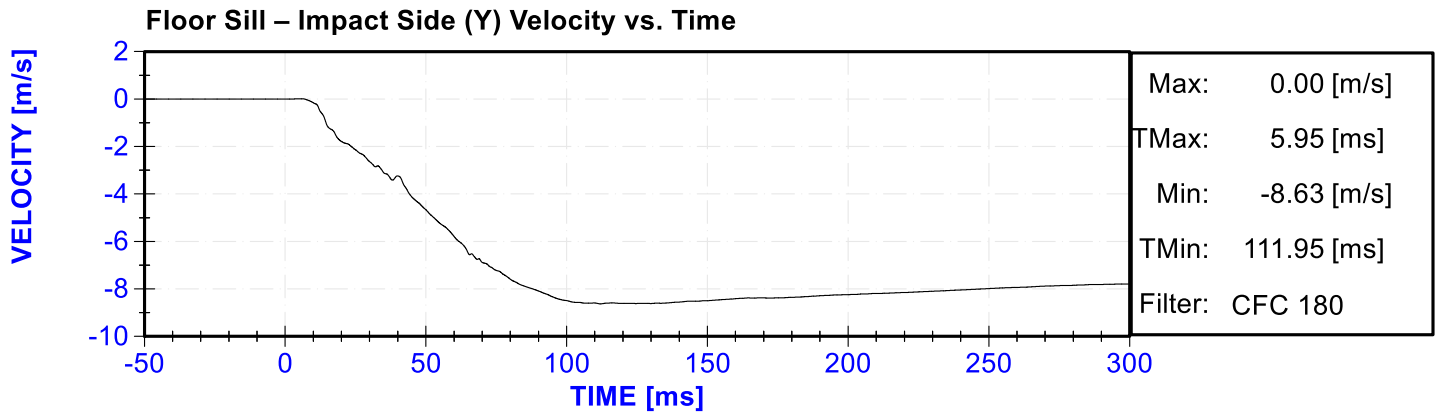
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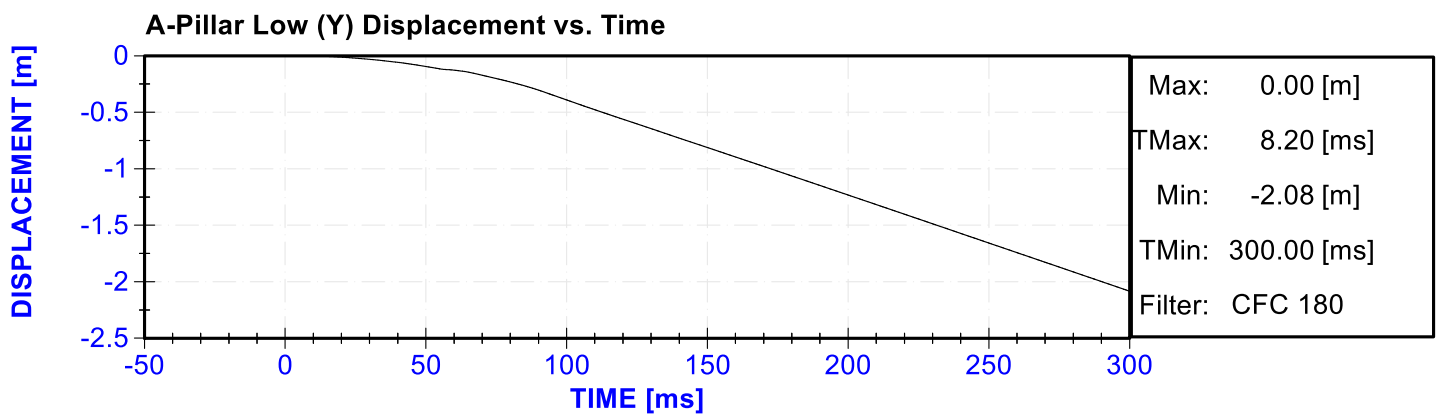
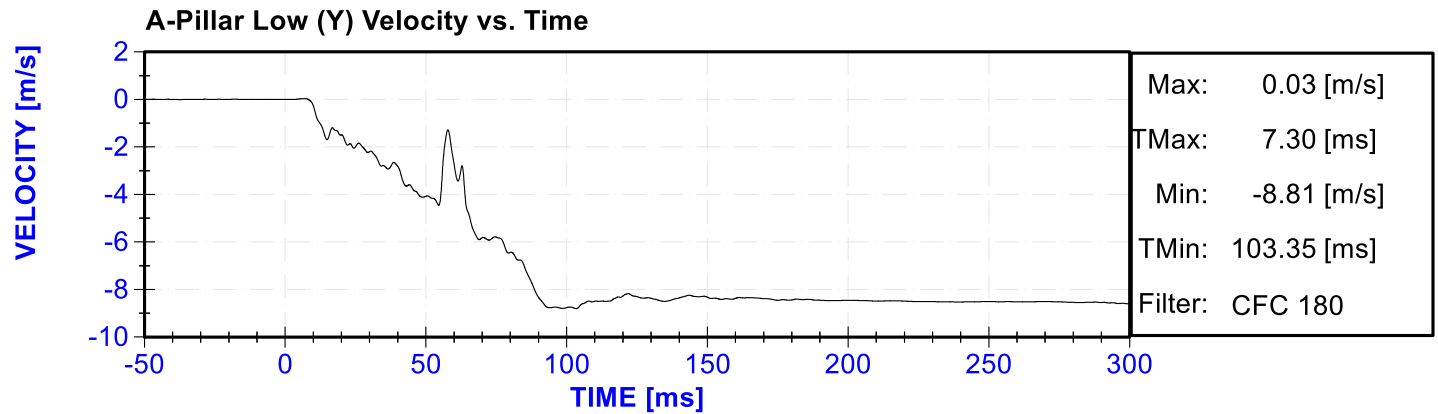
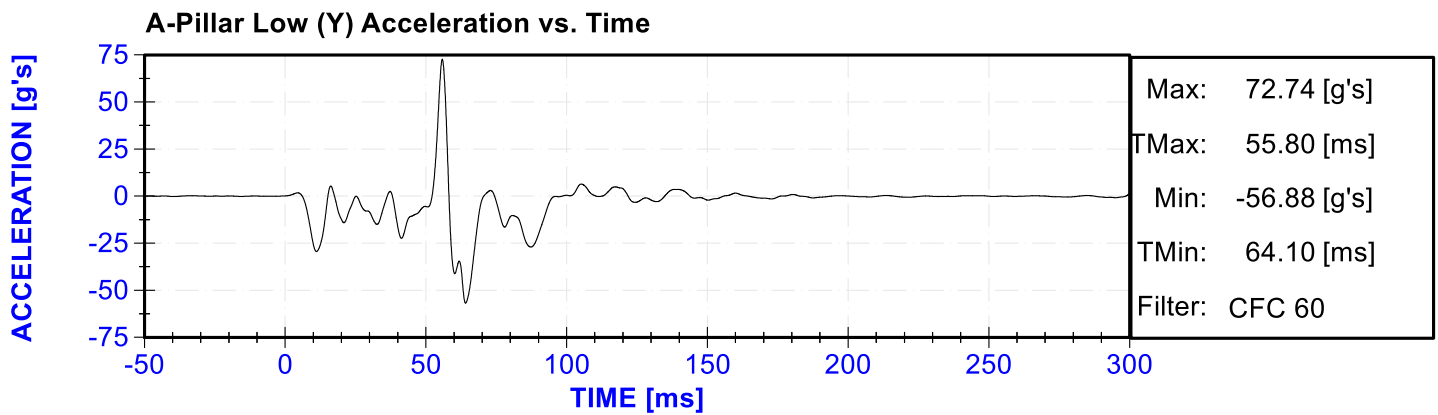
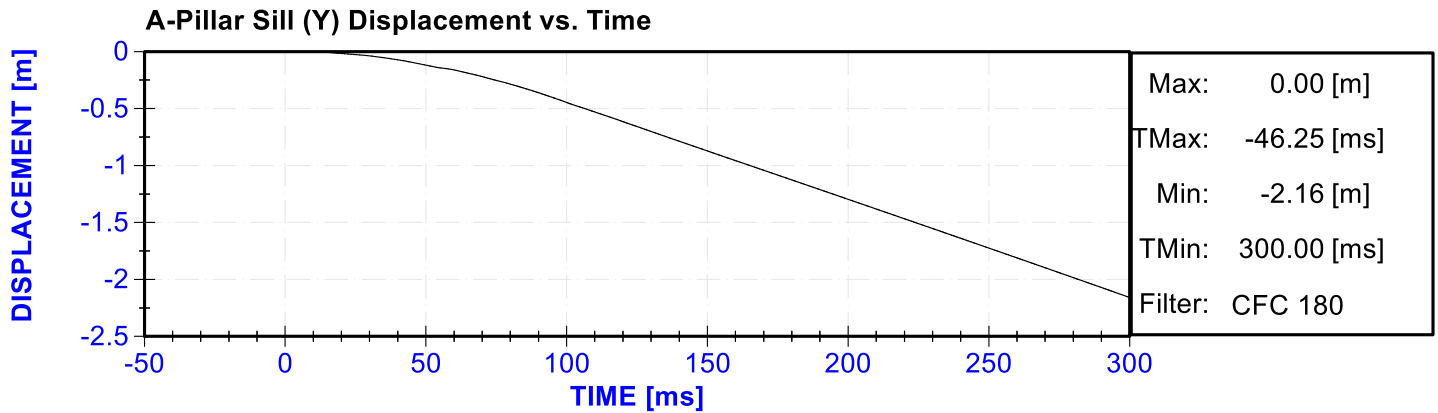
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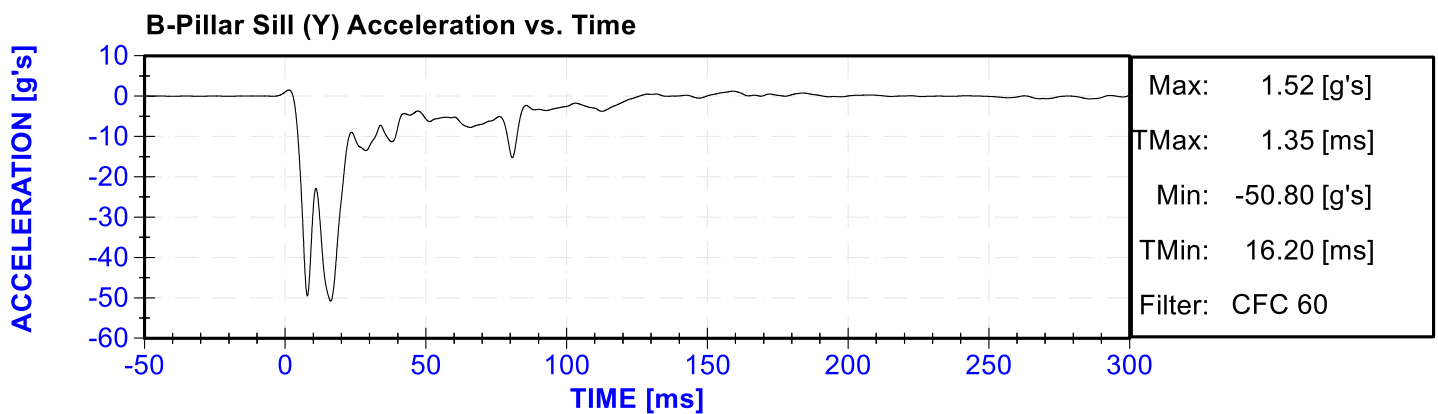
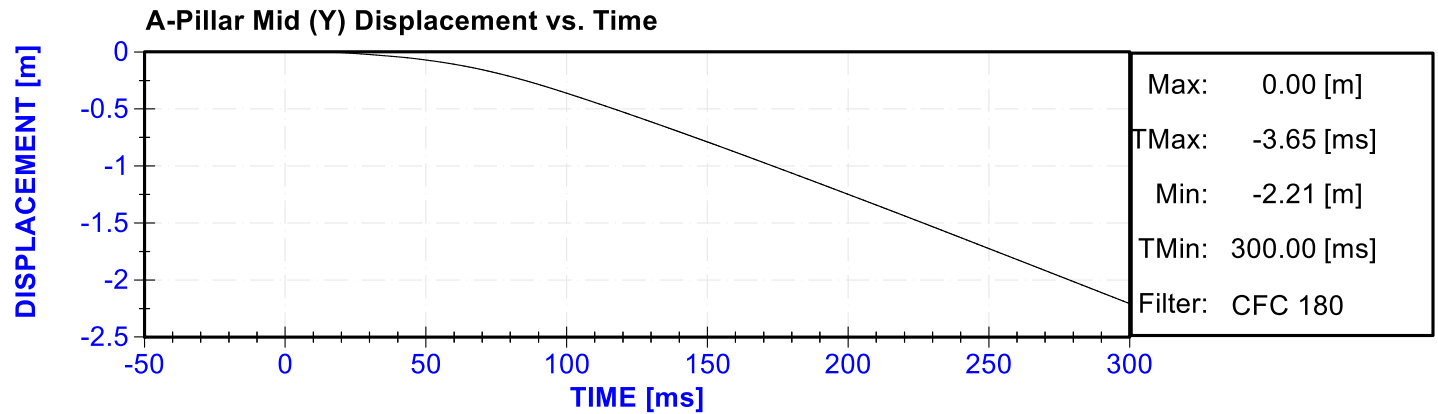
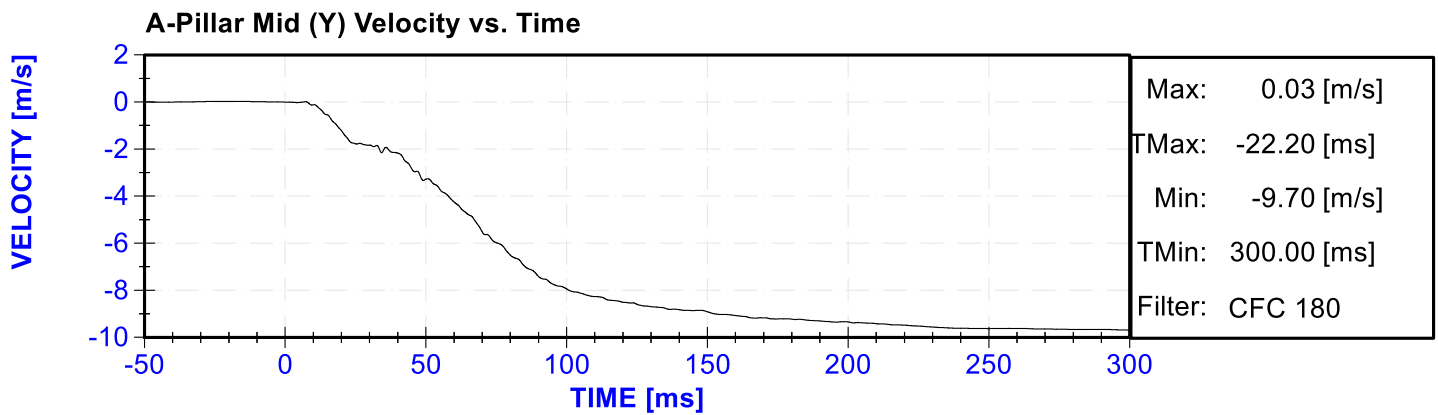
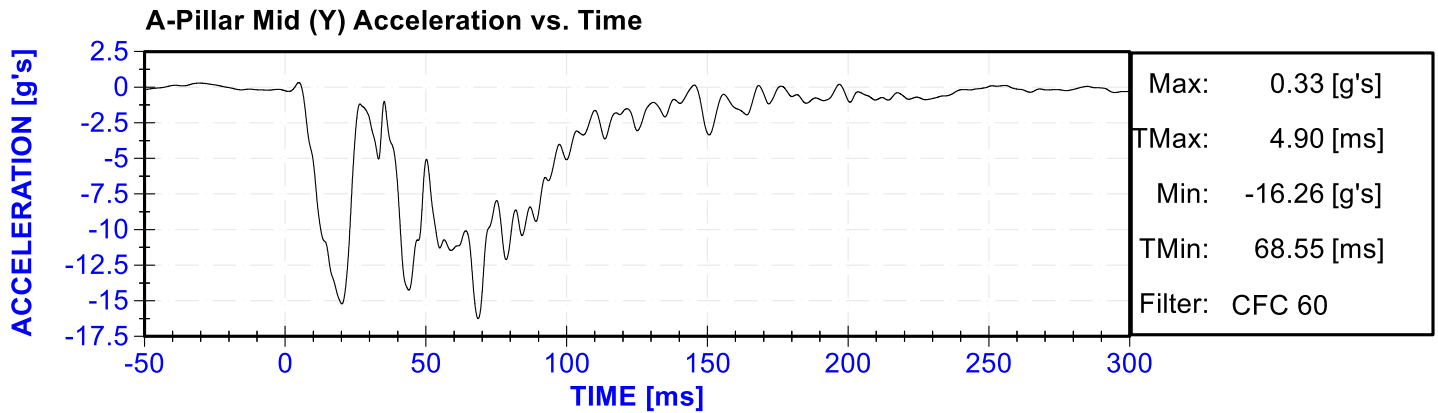
No.	Description	Page
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Plot 2	Vehicle Center of Gravity (X) Velocity vs. Time	III-3
Plot 3	Vehicle Center of Gravity (Y) Acceleration vs. Time	III-3
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Plot 45	Rear Deck (Y) Velocity vs. Time	III-14

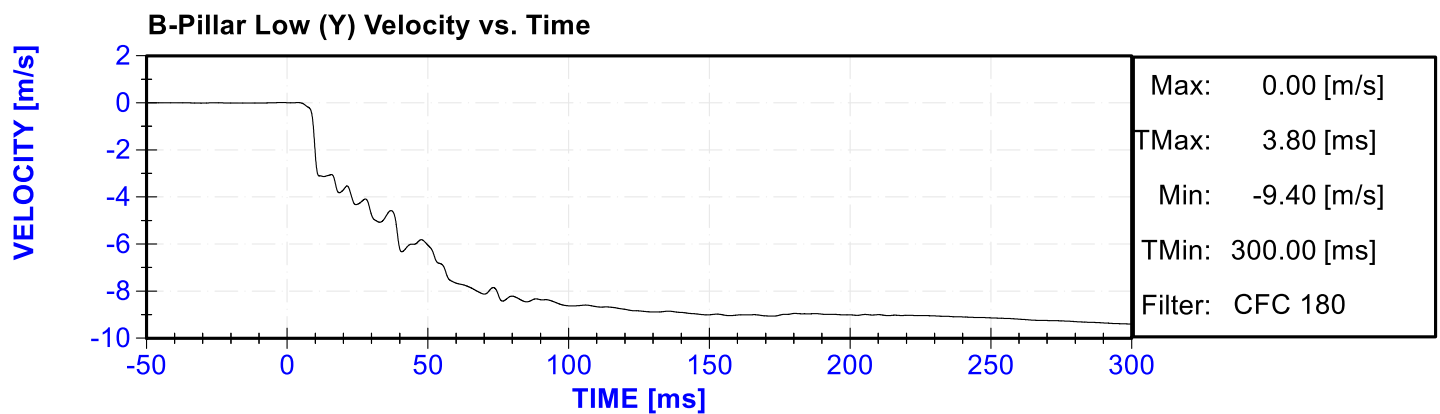
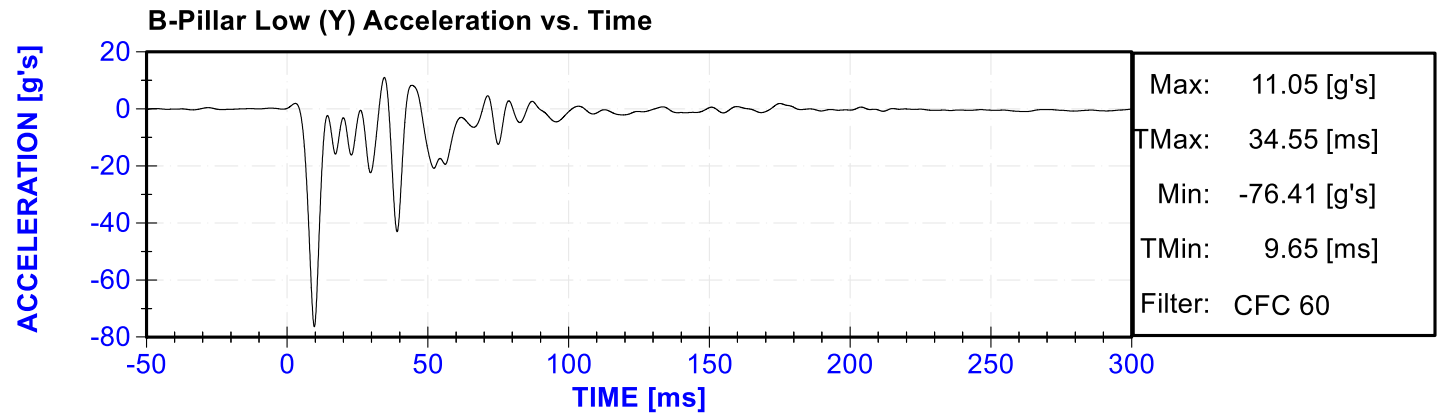
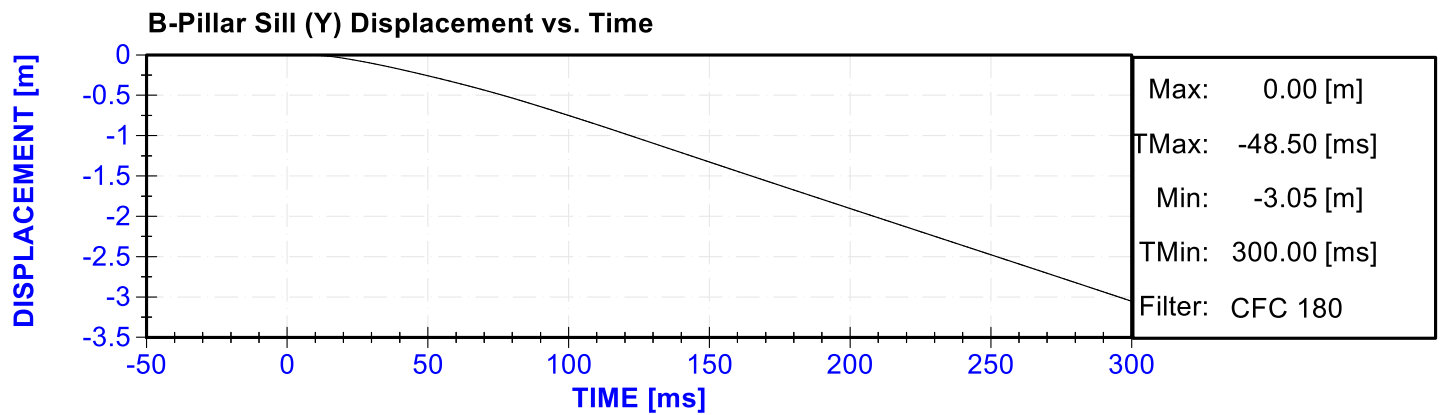
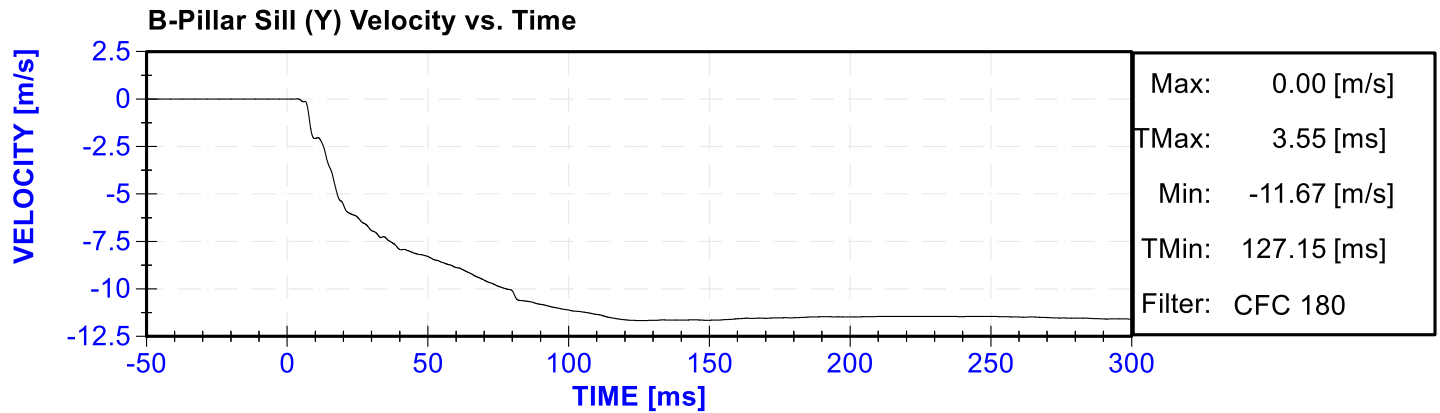


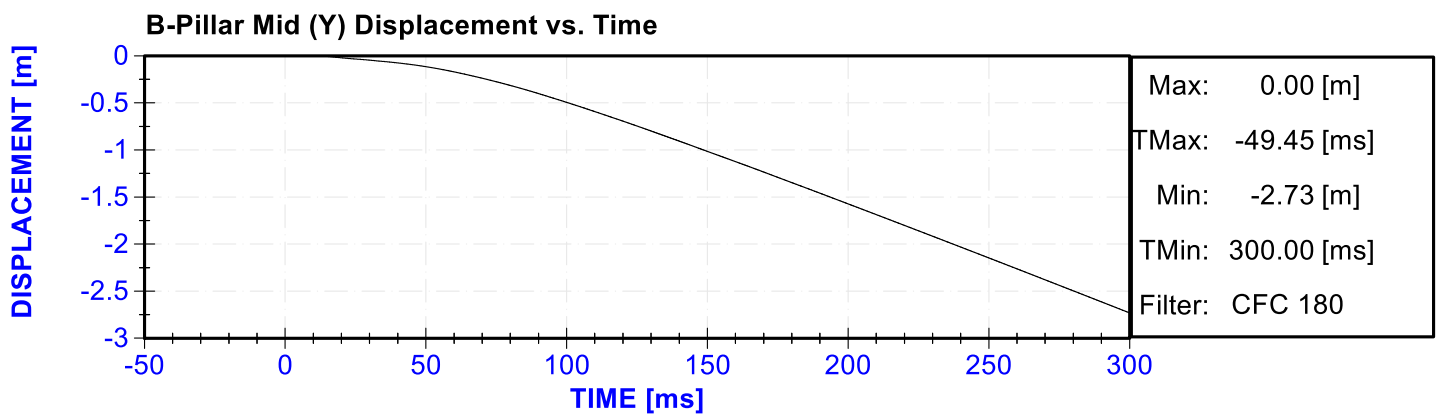
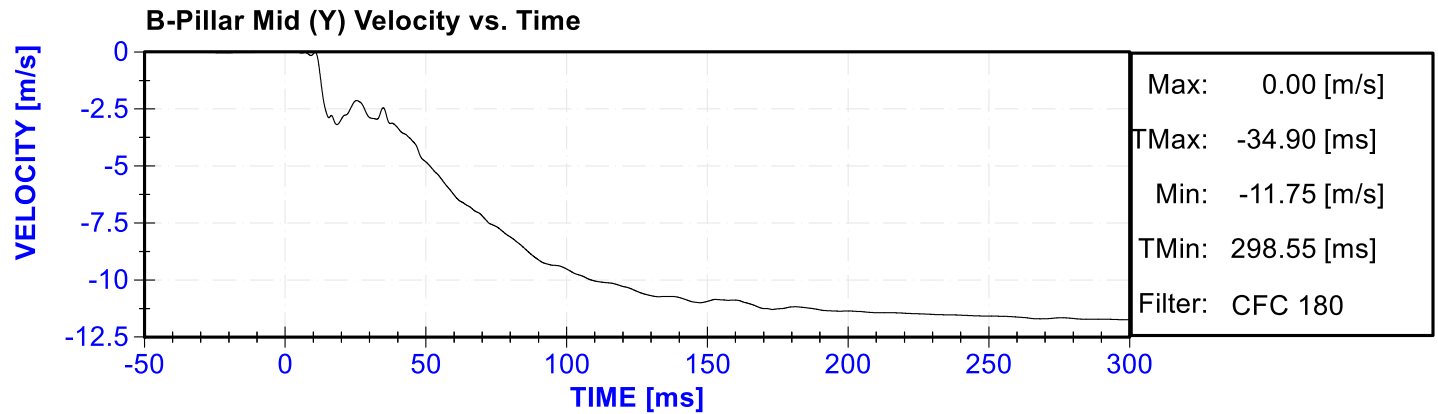
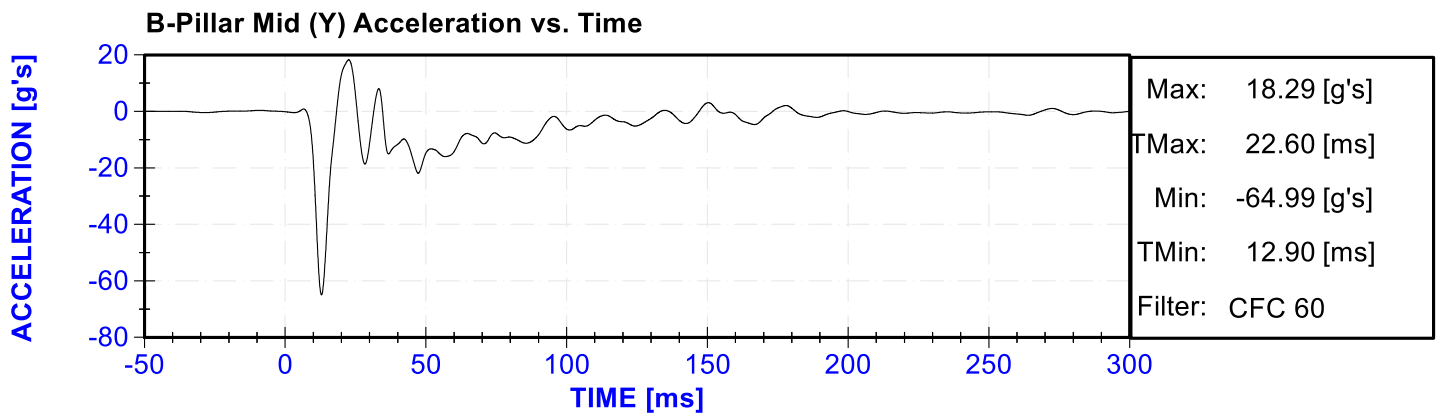
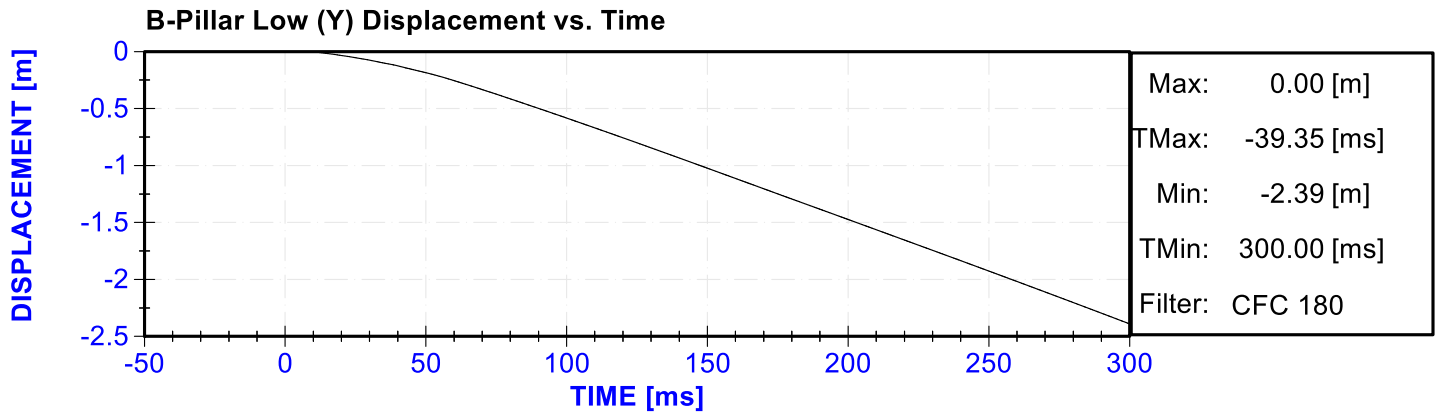


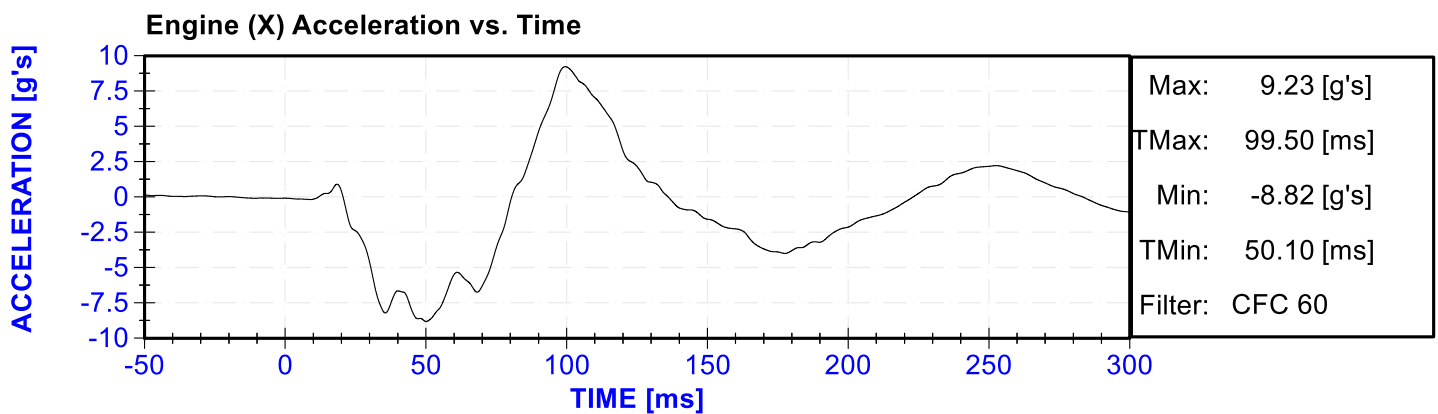
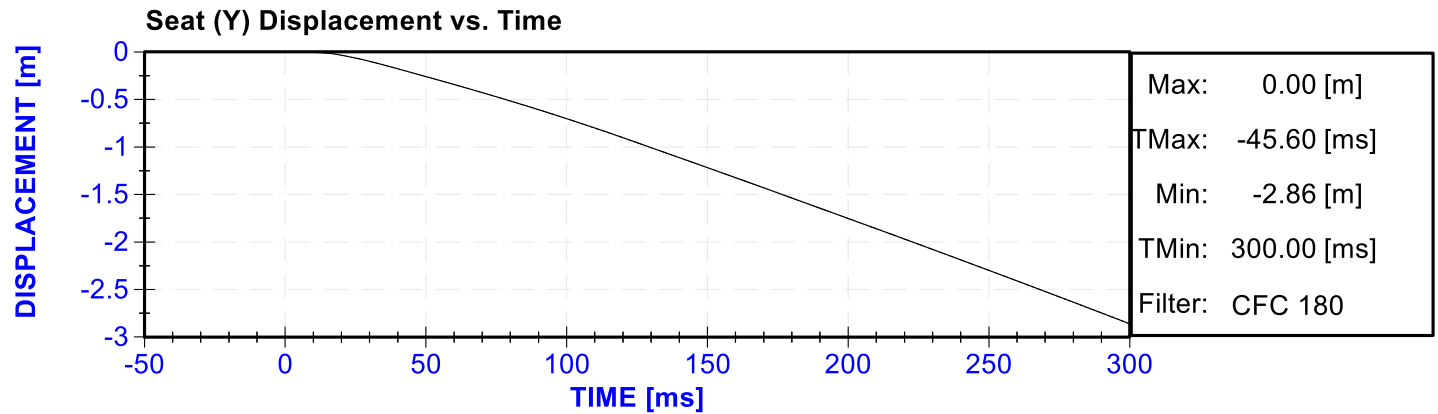
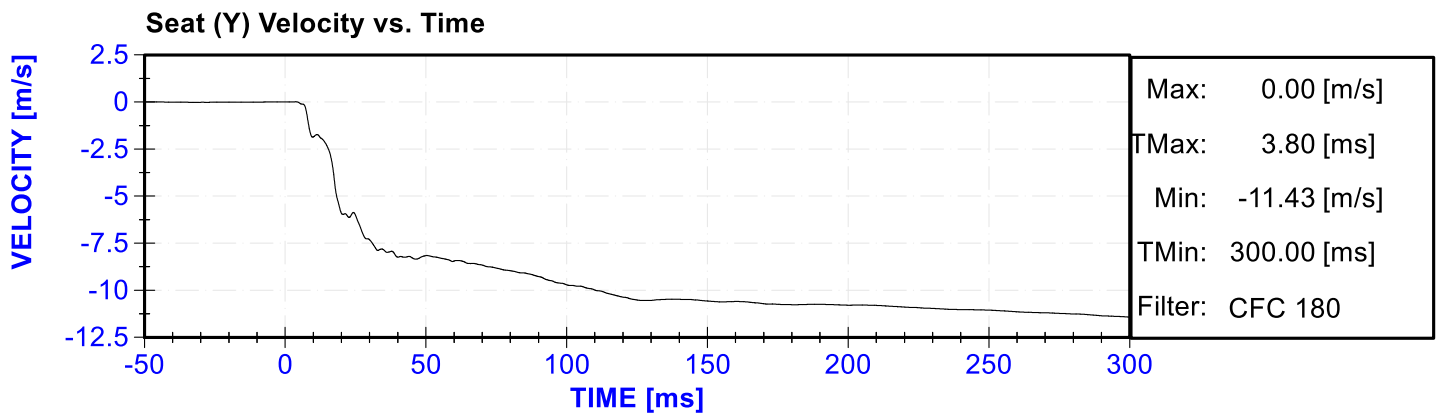
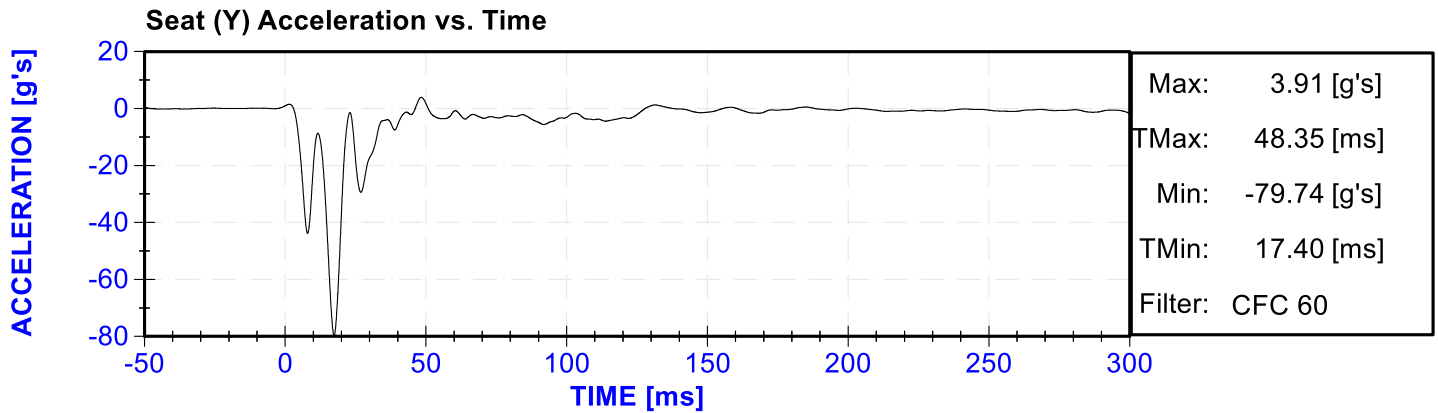


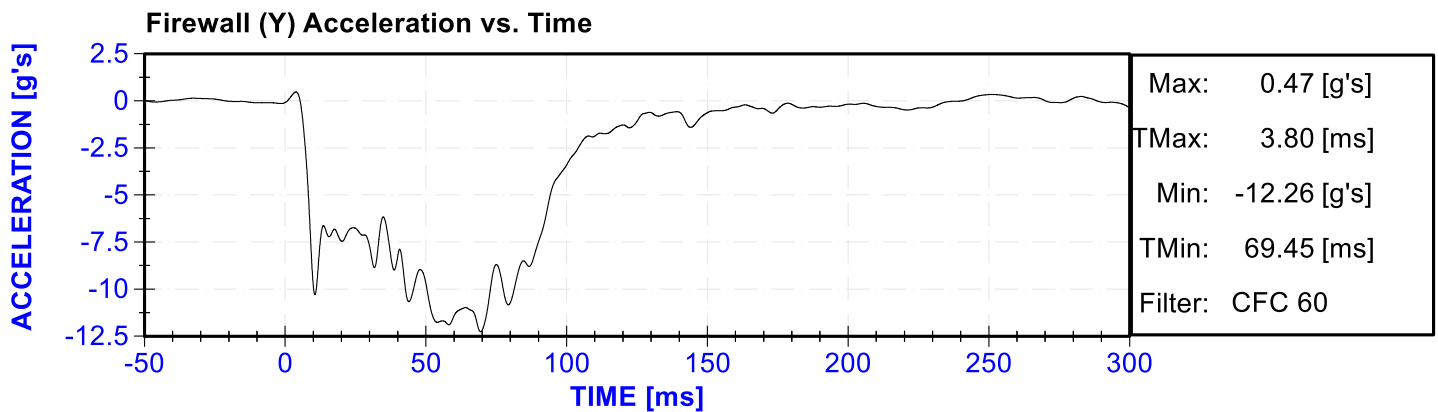
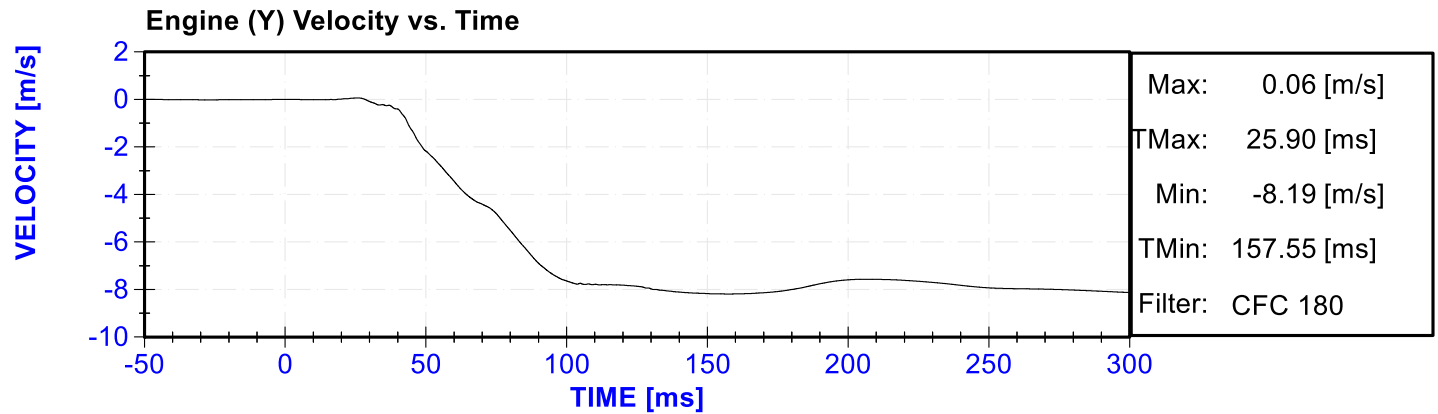
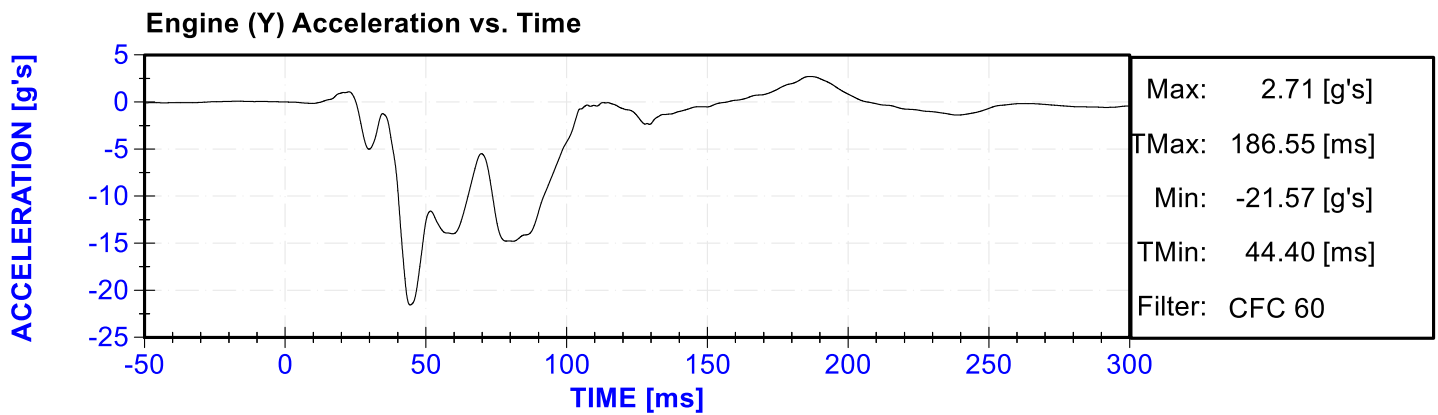
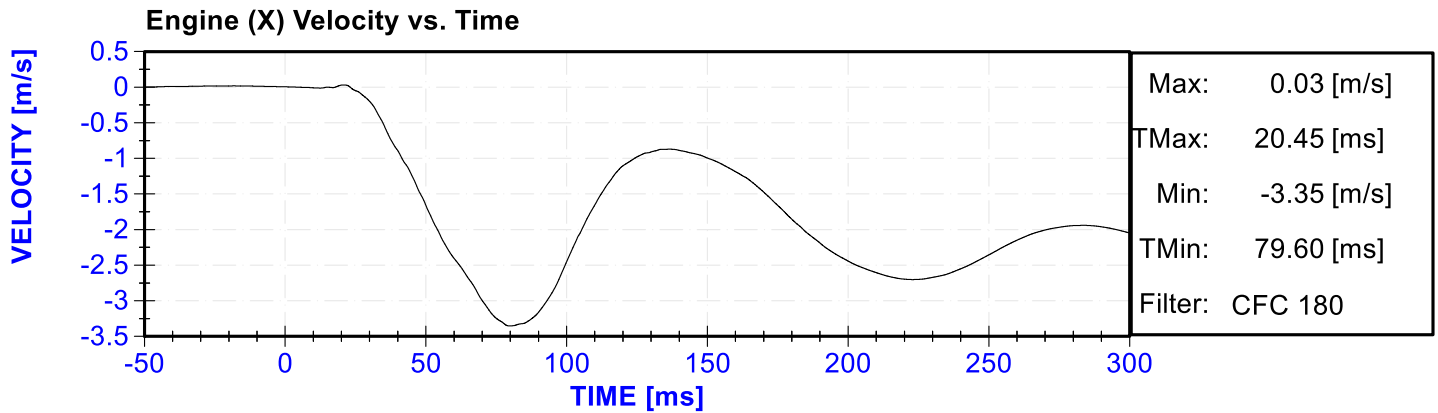


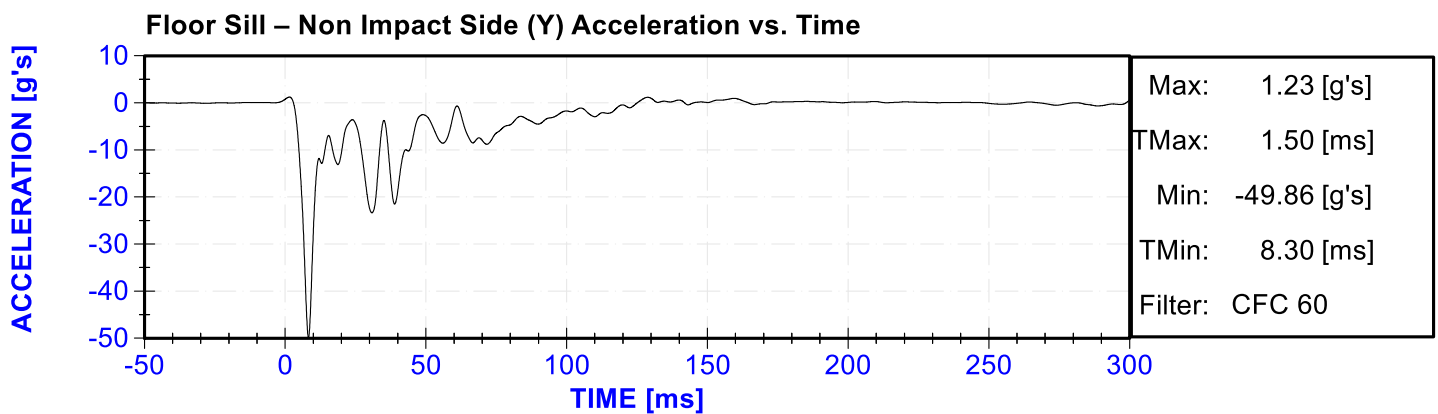
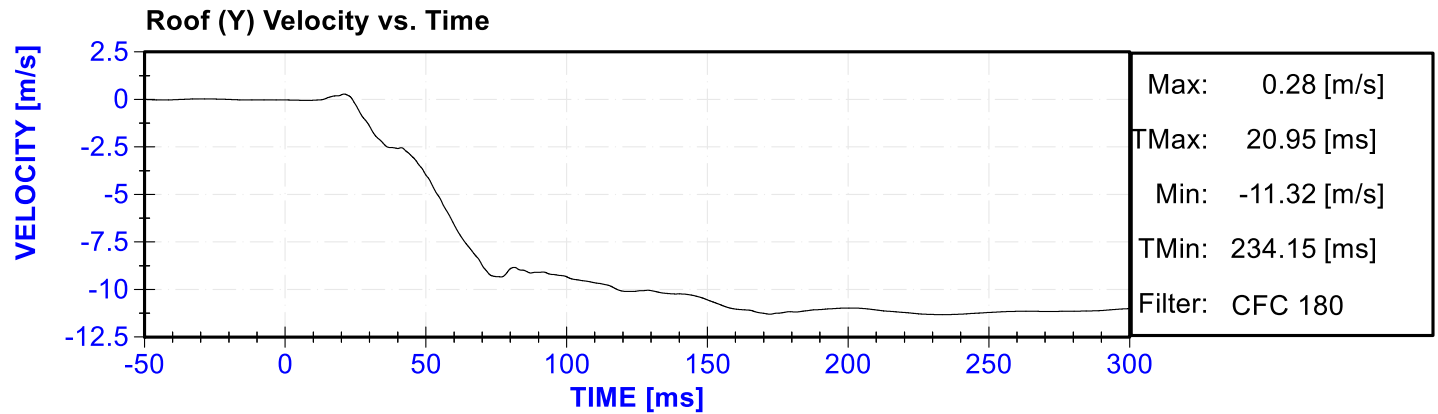
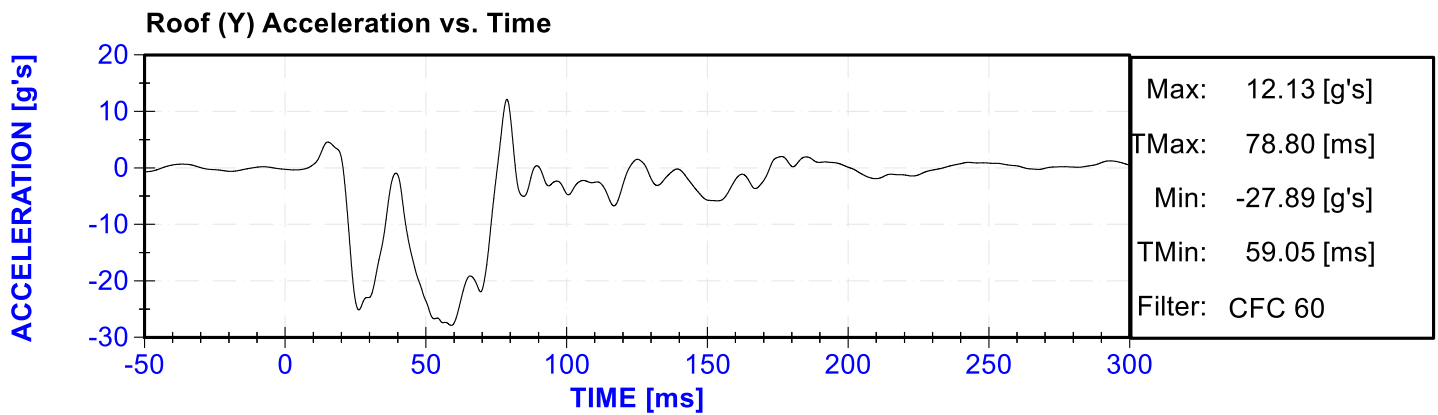
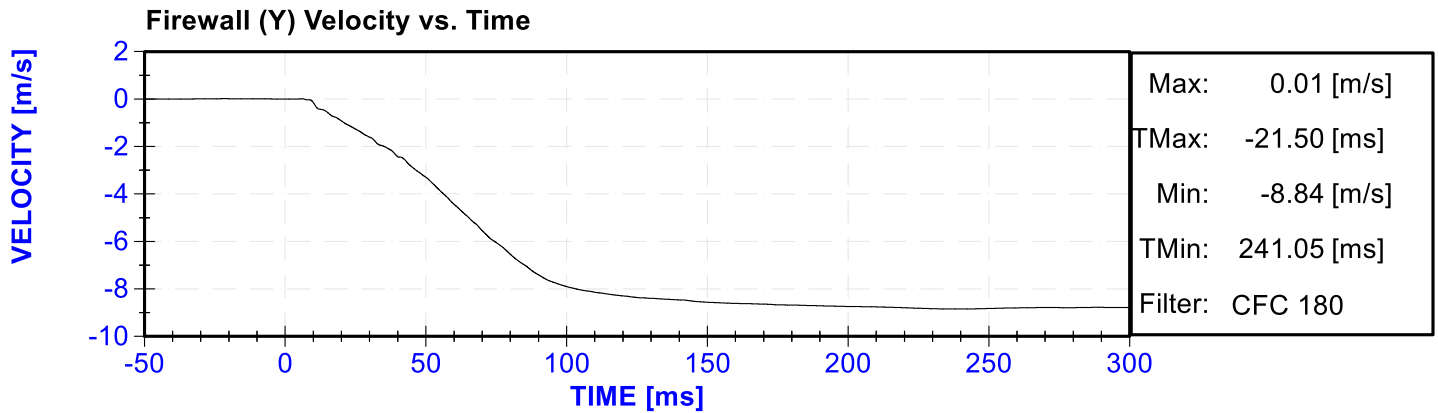


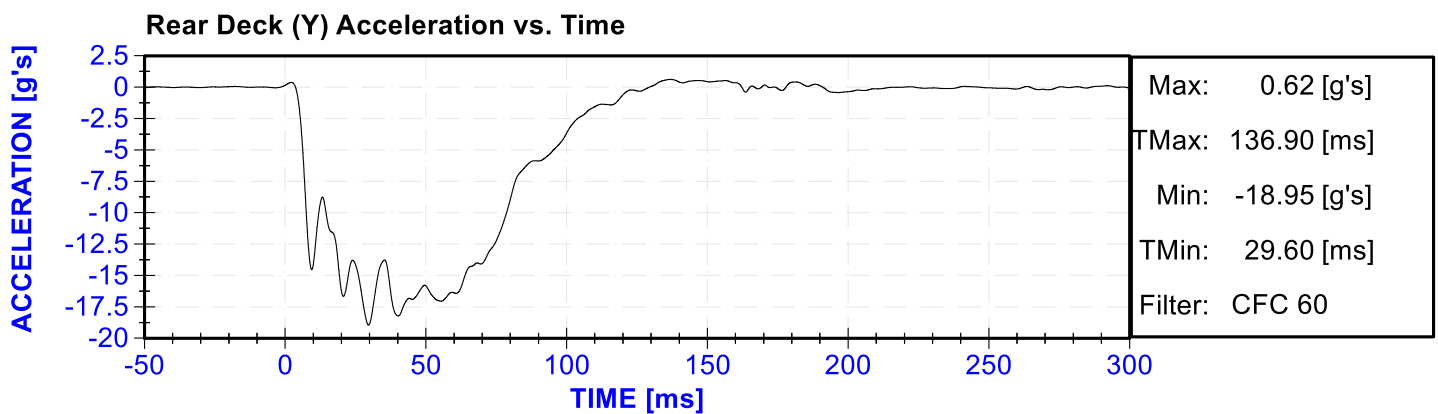
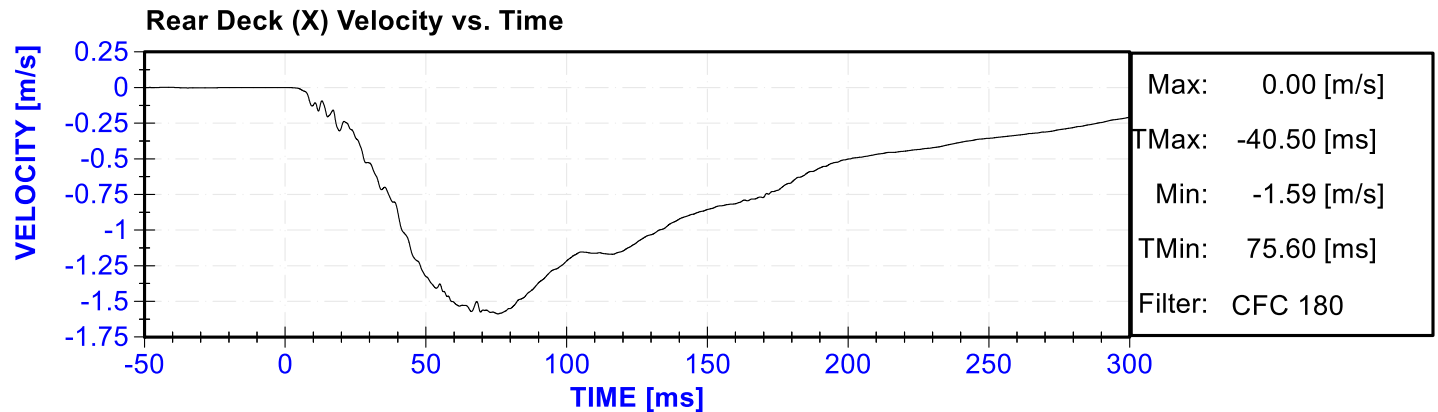
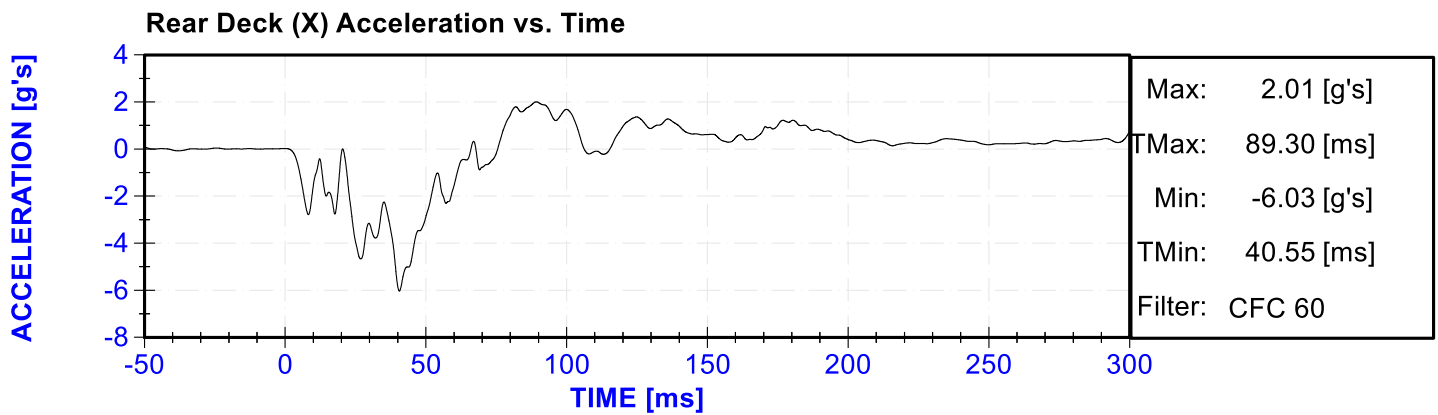
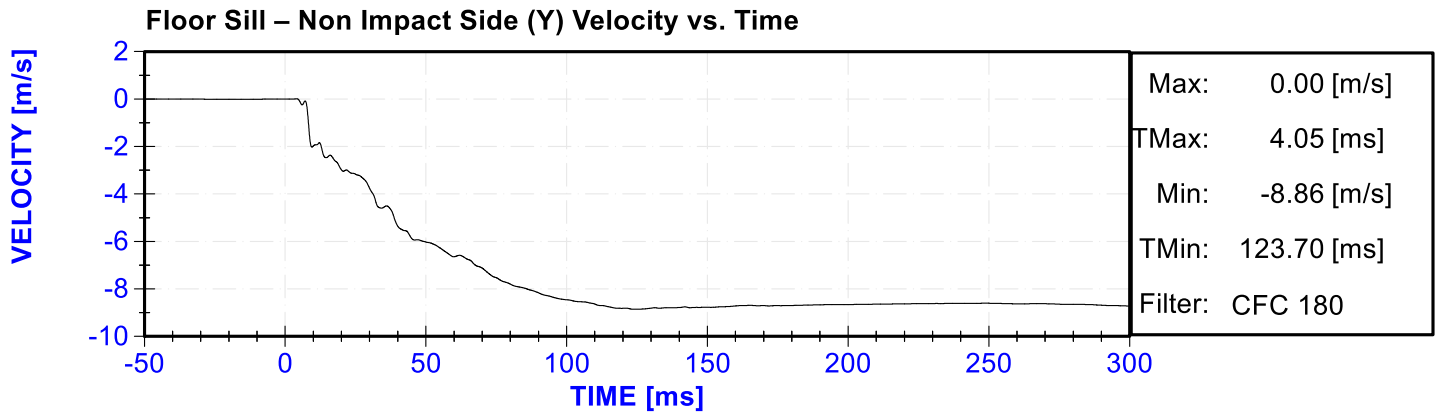


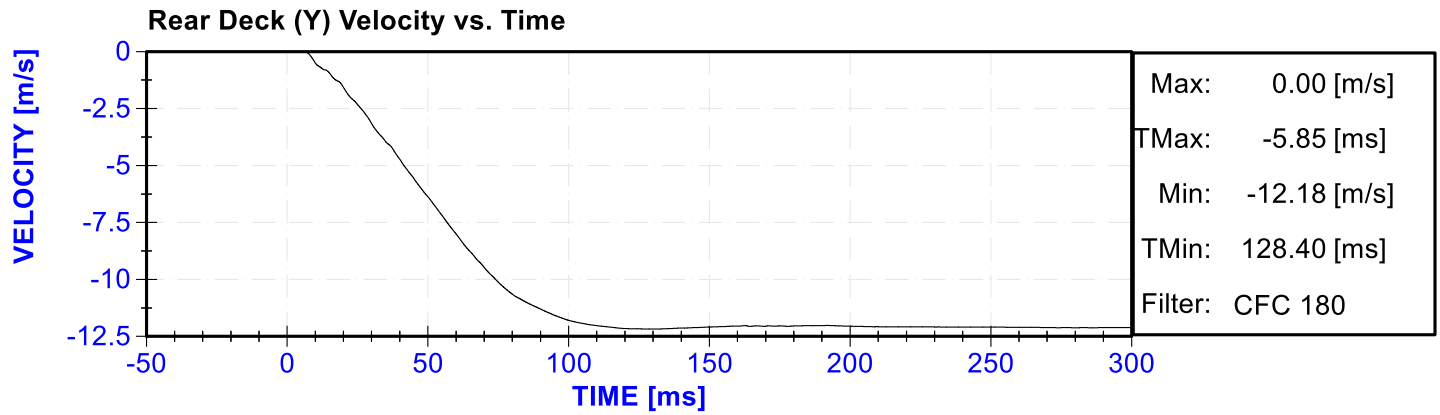












APPENDIX IV

PRE-TEST DUMMY PERFORMANCE CALIBRATION TEST DATA (Subpart U, ES-2re)

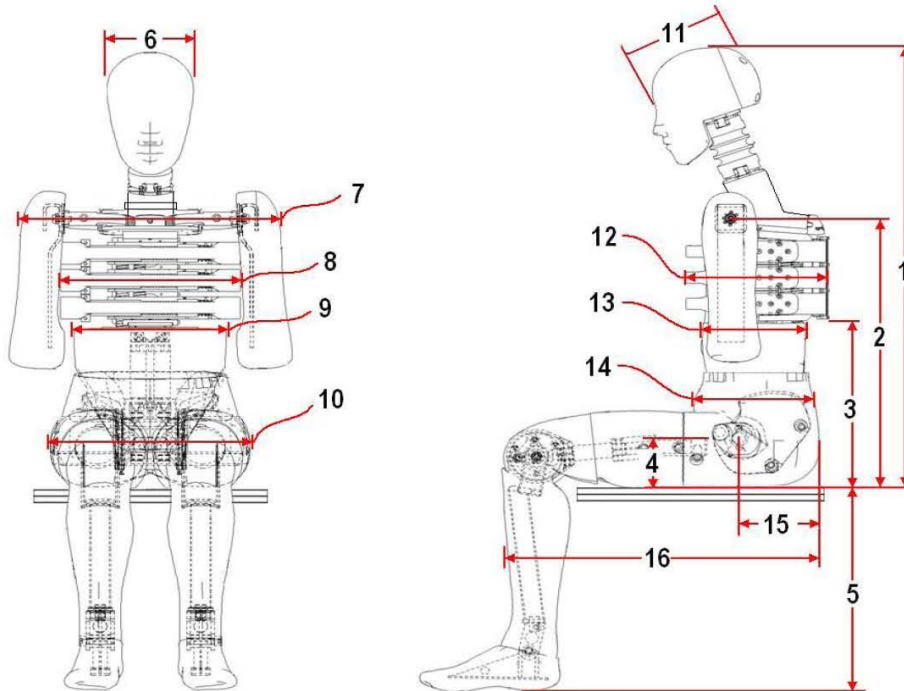


External Measurements - EuroSID-2re

Technician: K. Dutton

Date: 5/7/2019

Dummy Serial Number: DG5348



FRONT VIEW

SIDE VIEW

Dim. No.	Description	Specification (mm)		Result (mm)	Pass/Fail
1	Sitting Height	900	918	915	Pass
2	Seat to Shoulder Joint	558	572	566	Pass
3	Seat to Lower Face of Thoracic Spine Box	346	356	352	Pass
4	Seat to Hip Joint (center of bolt)	97	103	100	Pass
5	Sole to Seat, Sitting	333	451	399	Pass
6	Head Width	152	158	155	Pass
7	Shoulder/Arm Width	461	479	473	Pass
8	Thorax Width	322	332	324	Pass
9	Abdomen Width	273	287	280	Pass
10	Pelvis Lap Width	359	373	366	Pass
11	Head Depth	196	206	202	Pass
12	Thorax Depth	262	272	267	Pass
13	Abdomen Depth	194	204	200	Pass
14	Pelvis Depth	235	245	242	Pass
15	Back of Buttocks to Hip Joint (center of bolt)	150	160	153	Pass
16	Back of Buttocks to Front Knee	597	615	604	Pass

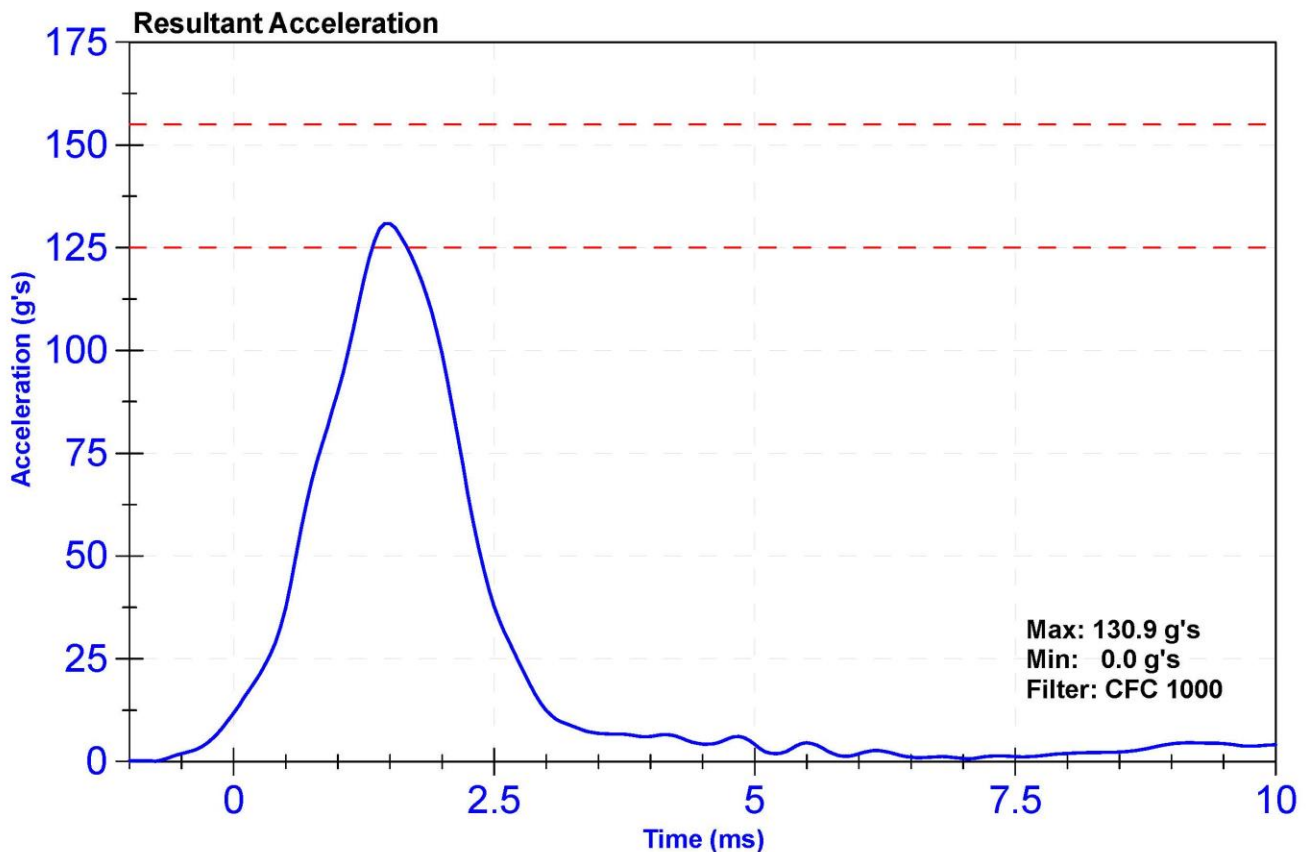
ATD Manufacturer	FTSS	Test Technician	C. Mantell
ATD Serial Number	DG5348	Laboratory Supervisor	K. Brogan

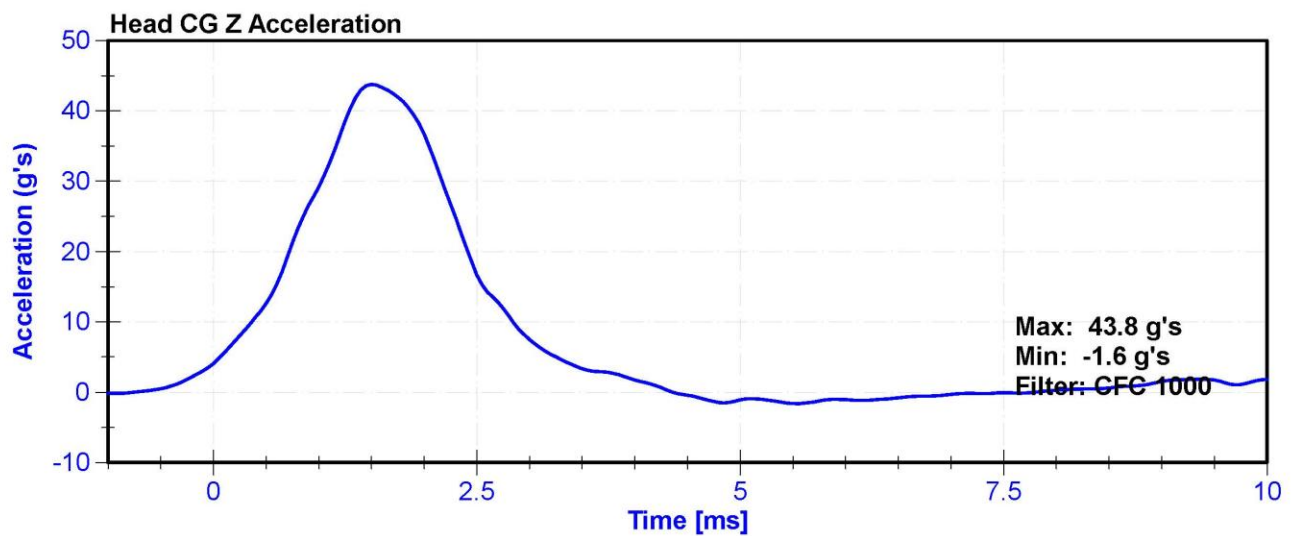
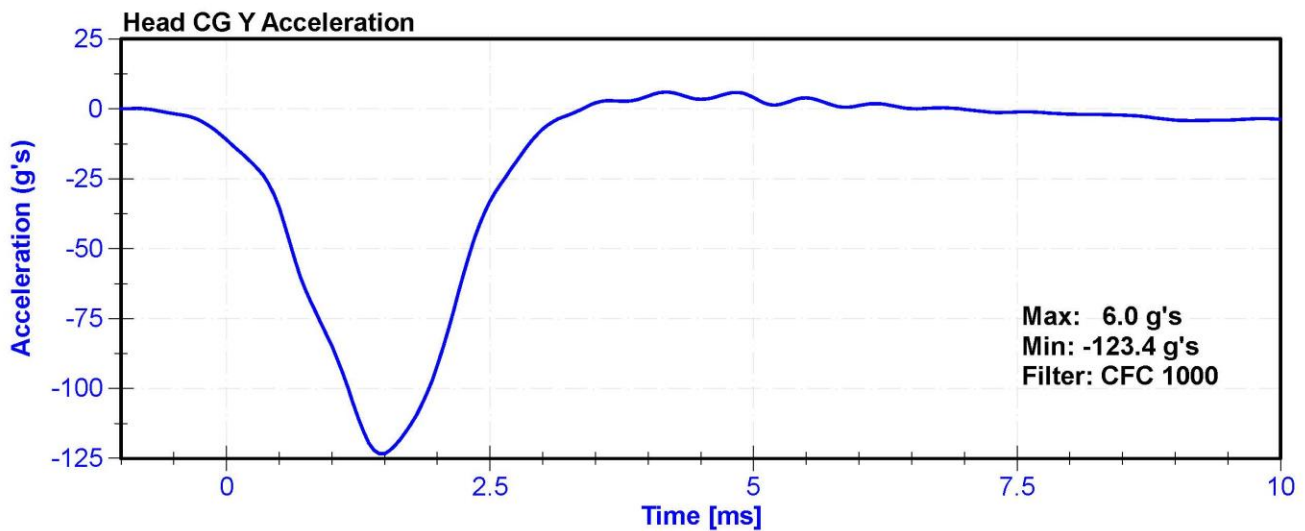
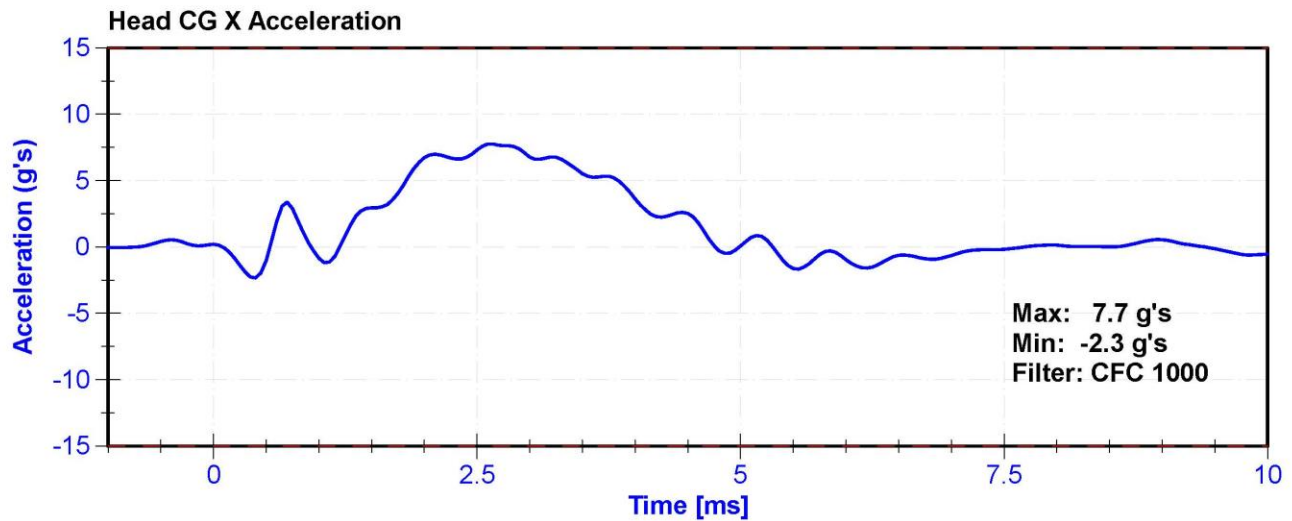
Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	20.6	Pass
Humidity	10	70	%	40.0	Pass
Resultant Acceleration	125	155	g's	130.9	Pass
Oscillation	0	15	%	5.00	Pass
Fore-Aft Acceleration	-15	15	g's	7.7	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
X Accelerometer	ENDEVCO 7264CT	AC-P58757	5/7/2019	11/5/2019
Y Accelerometer	ENDEVCO 7264CT	AC-P68062	5/7/2019	11/5/2019
Z Accelerometer	ENDEVCO 7264CT	AC-P68066	5/7/2019	11/5/2019





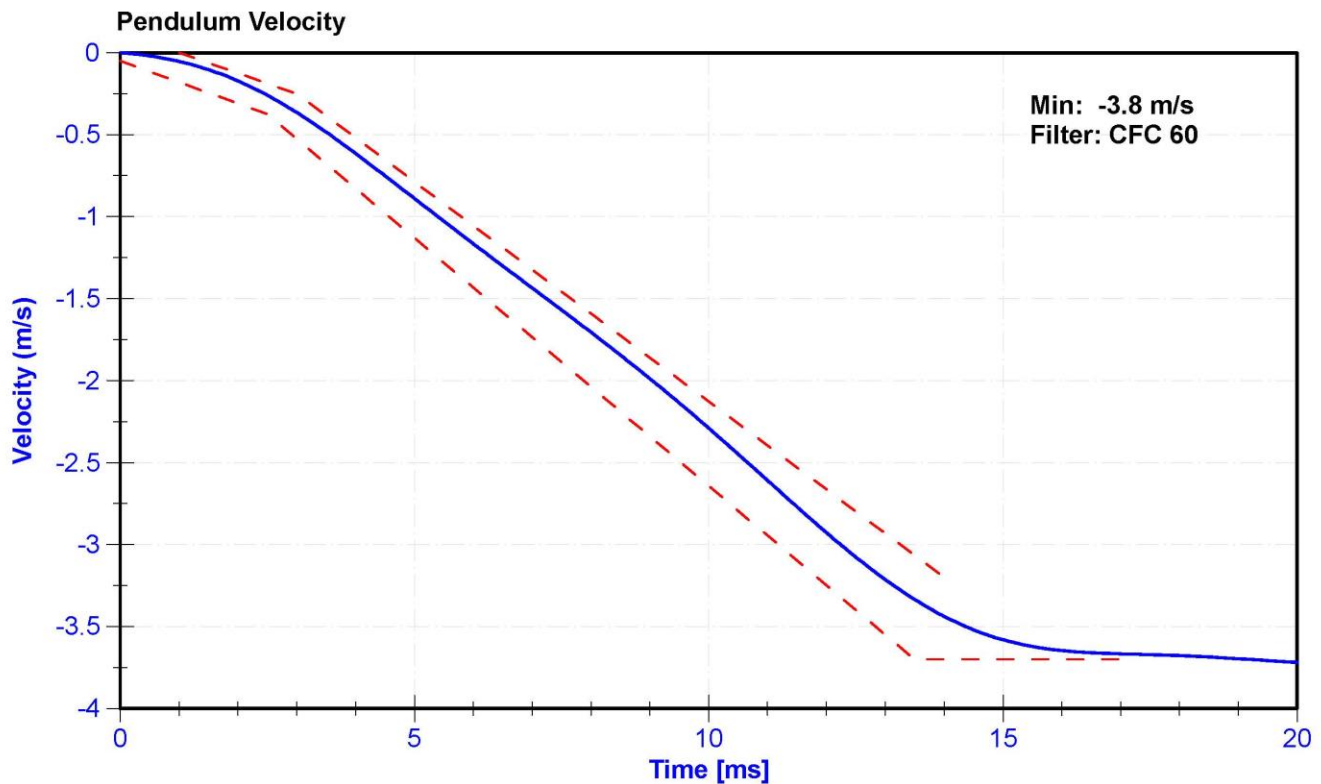
ATD Manufacturer	FTSS	Test Technician	K. Dutton
ATD Serial Number	DG5348	Laboratory Supervisor	K. Brogan

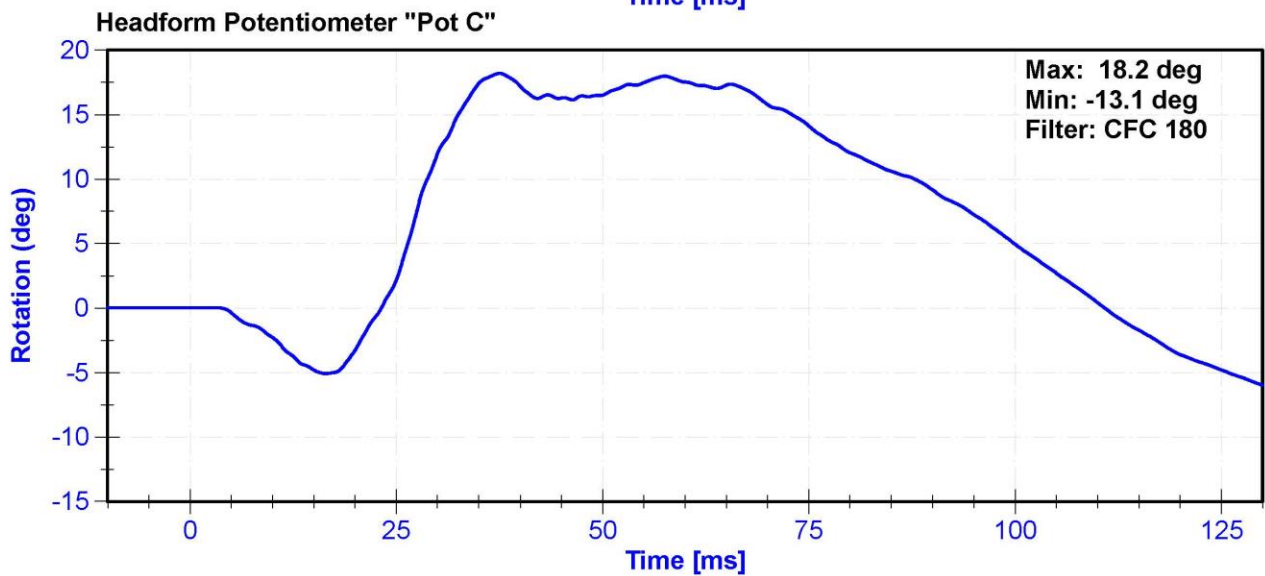
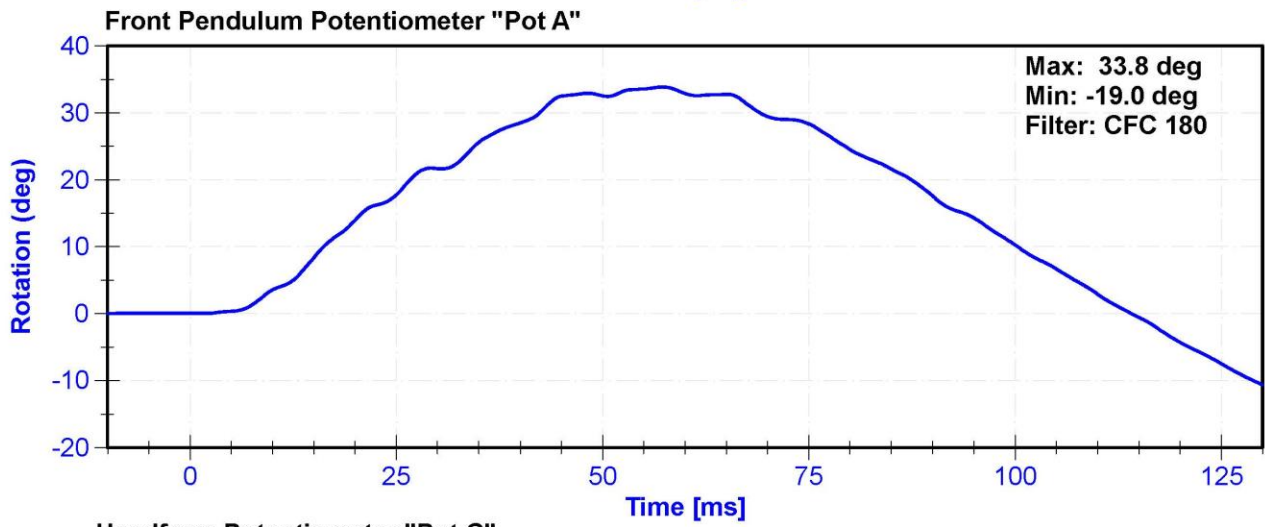
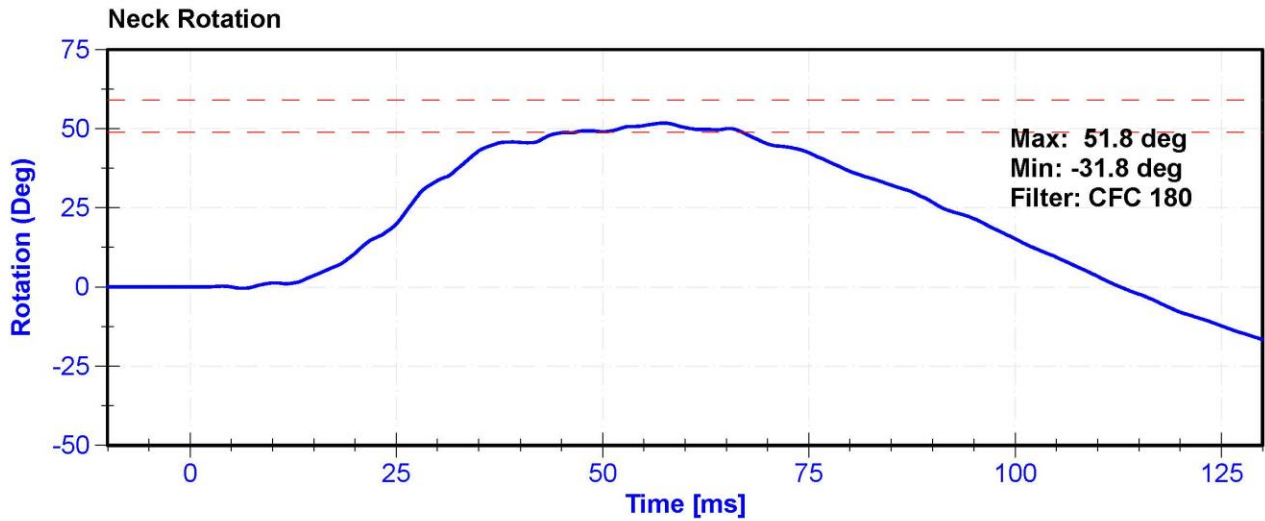
Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	20.8	Pass
Humidity	10	70	%	51.9	Pass
Velocity	3.3	3.5	m/s	3.38	Pass
Lateral Neck Rotation	49	59	deg	51.8	Pass
Time at Maximum Rotation	54	66	ms	57.4	Pass
Time of Rotation Decay from Maximum	53	88	ms	55.4	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	ENDEVCO 7231CTA	C-AH5M9 Pend	1/29/2019	1/29/2020
Front Pendulum Potentiometer	SP22G	DS-094	10/31/2018	10/31/2019
Headform Potentiometer	SP22G	DS-095	10/31/2018	10/31/2019







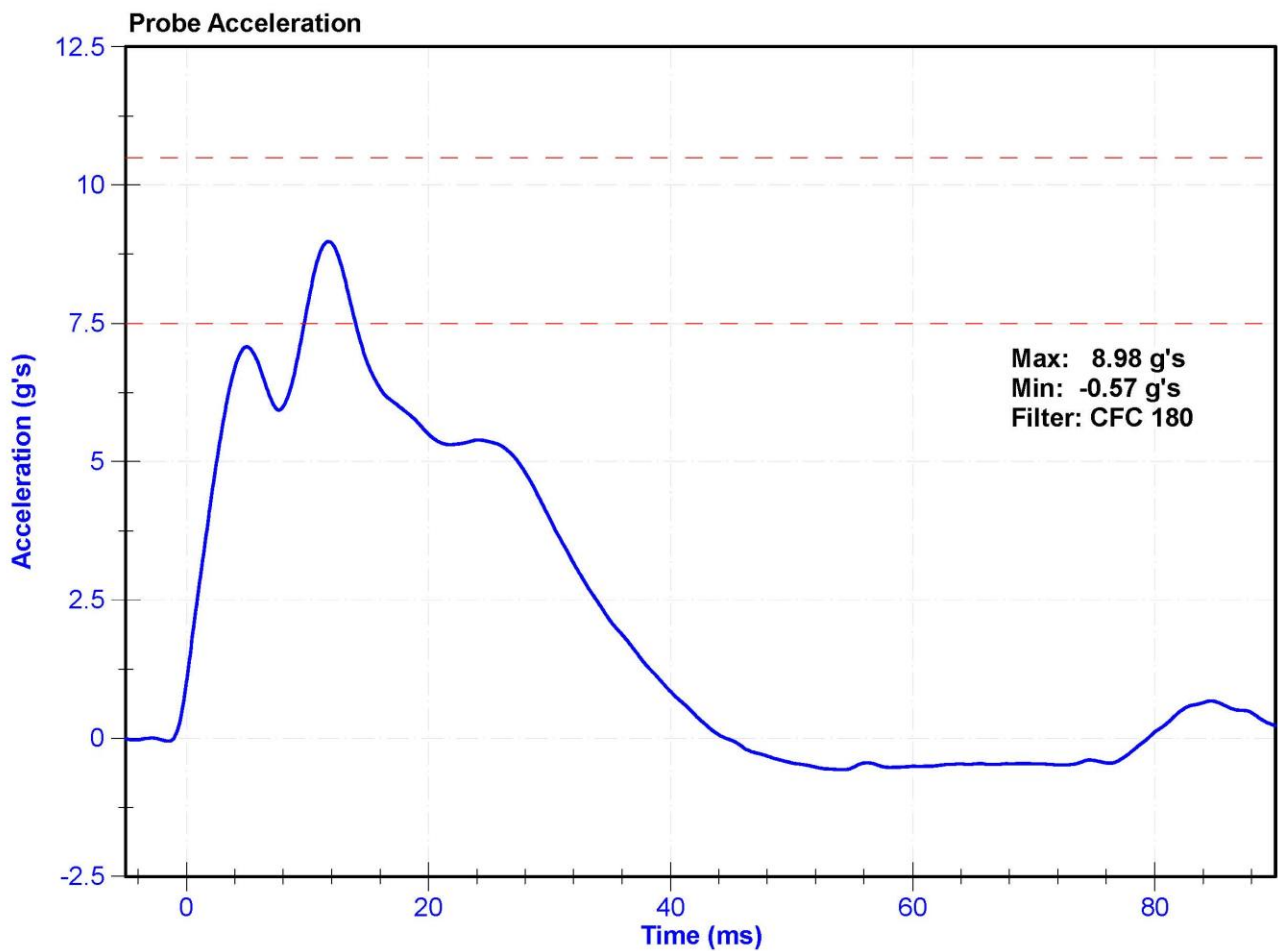
ATD Manufacturer	FTSS	Test Technician	K. Dutton
ATD Serial Number	DG5348	Laboratory Supervisor	K. Brogan

Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	21.5	Pass
Humidity	10	70	%	38.4	Pass
Velocity	4.2	4.4	m/s	4.40	Pass
Probe Acceleration	7.5	10.5	g's	8.98	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Probe Accelerometer	MSI 64C-2000	A260487	2/21/2019	8/22/2019





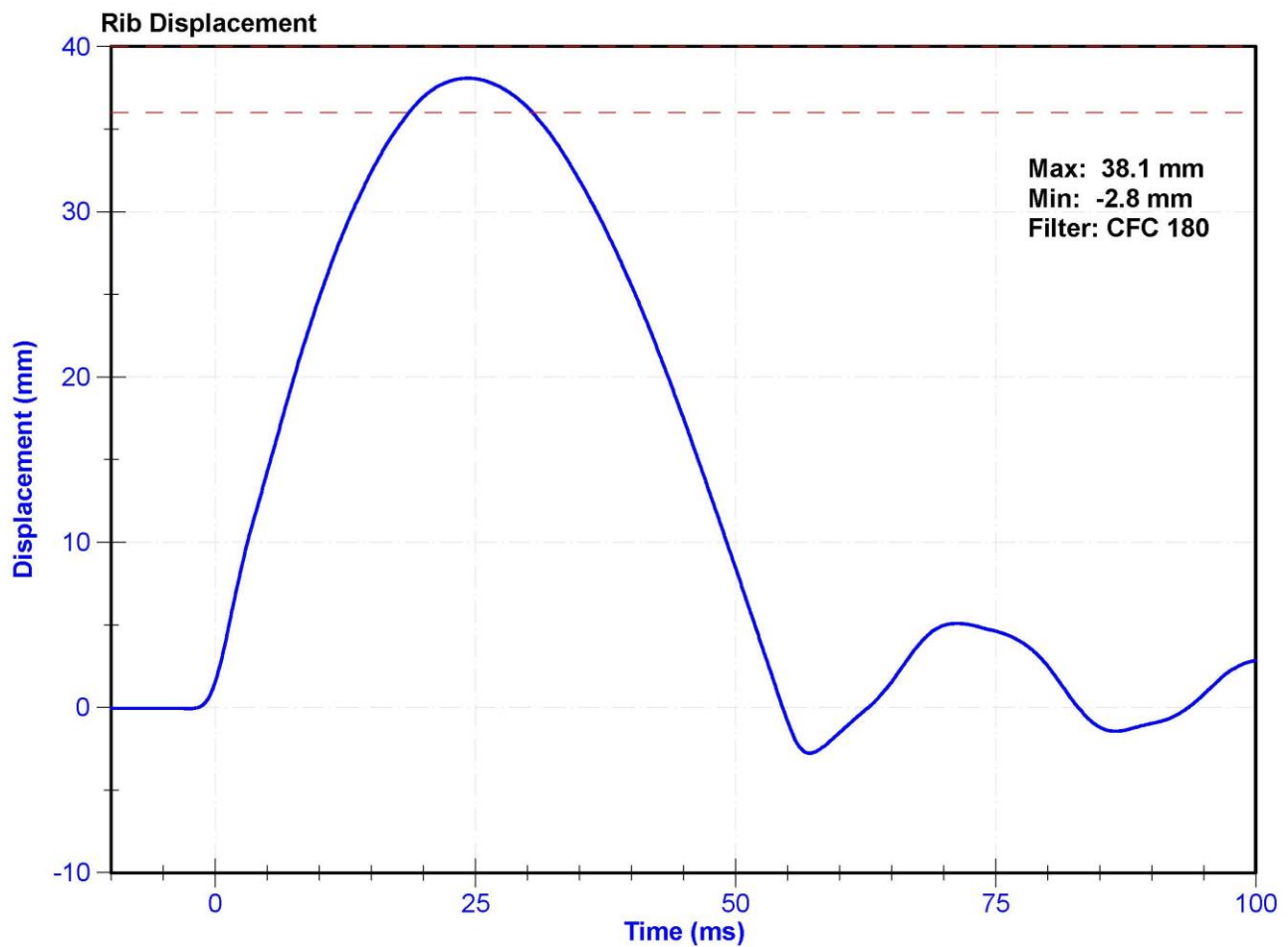
ATD Manufacturer	FTSS	Test Technician	D.Reinhard
ATD Serial Number	DG5348	Laboratory Supervisor	K. Brogan

Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	20.6	Pass
Humidity	10	70	%	50.5	Pass
Rib Displacement	36	40	mm	38.1	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Rib Potentiometer	Honeywell MLT-38000203	DS-268GFE	11/27/2018	11/27/2019





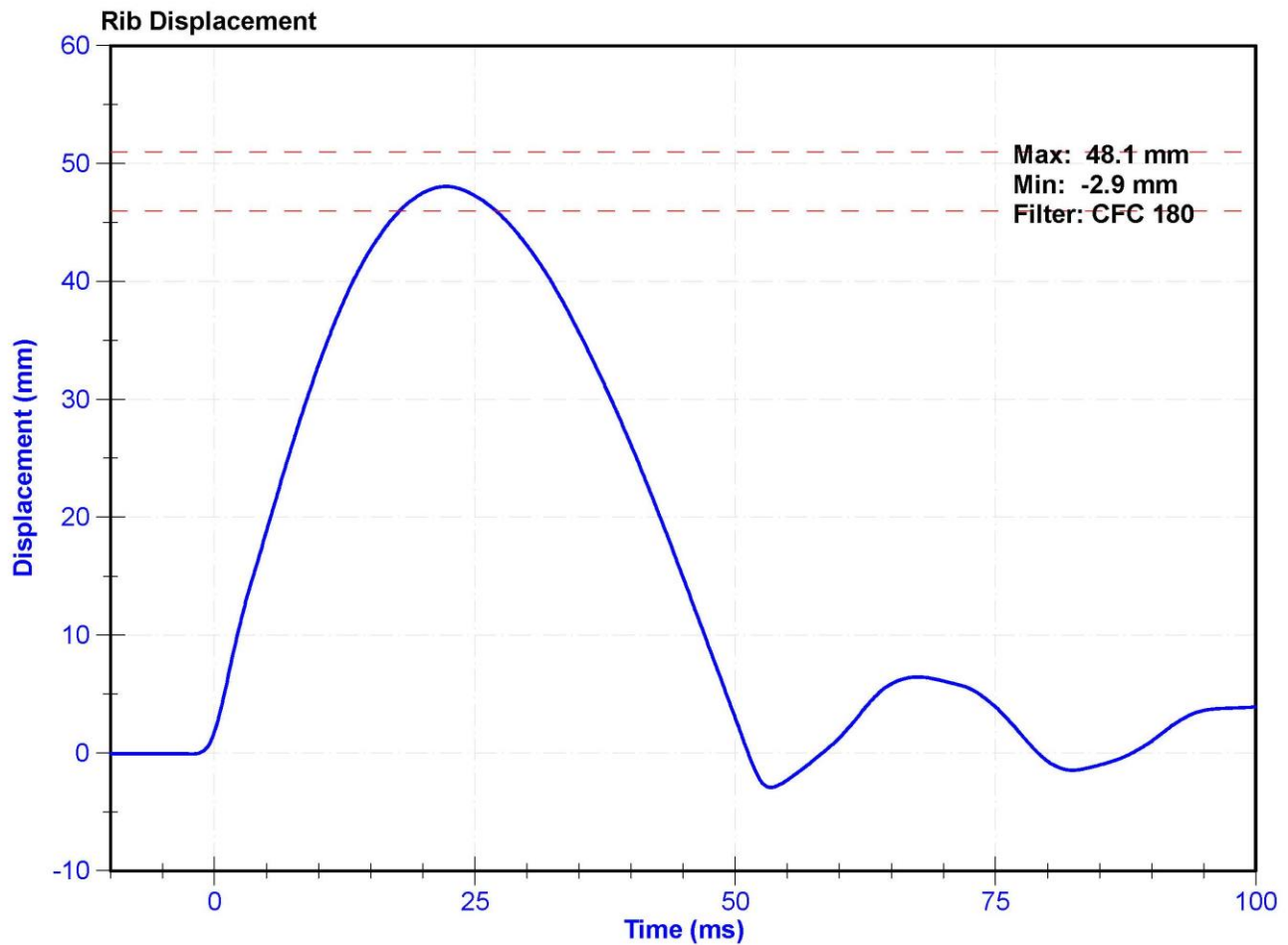
ATD Manufacturer	FTSS	Test Technician	D.Reinhard
ATD Serial Number	DG5348	Laboratory Supervisor	K. Brogan

Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	22.0	Pass
Humidity	10	70	%	16.5	Pass
Rib Displacement	46	51	mm	48.1	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Rib Potentiometer	Honeywell MLT-38000203	DS-268GFE	11/27/2018	11/27/2019



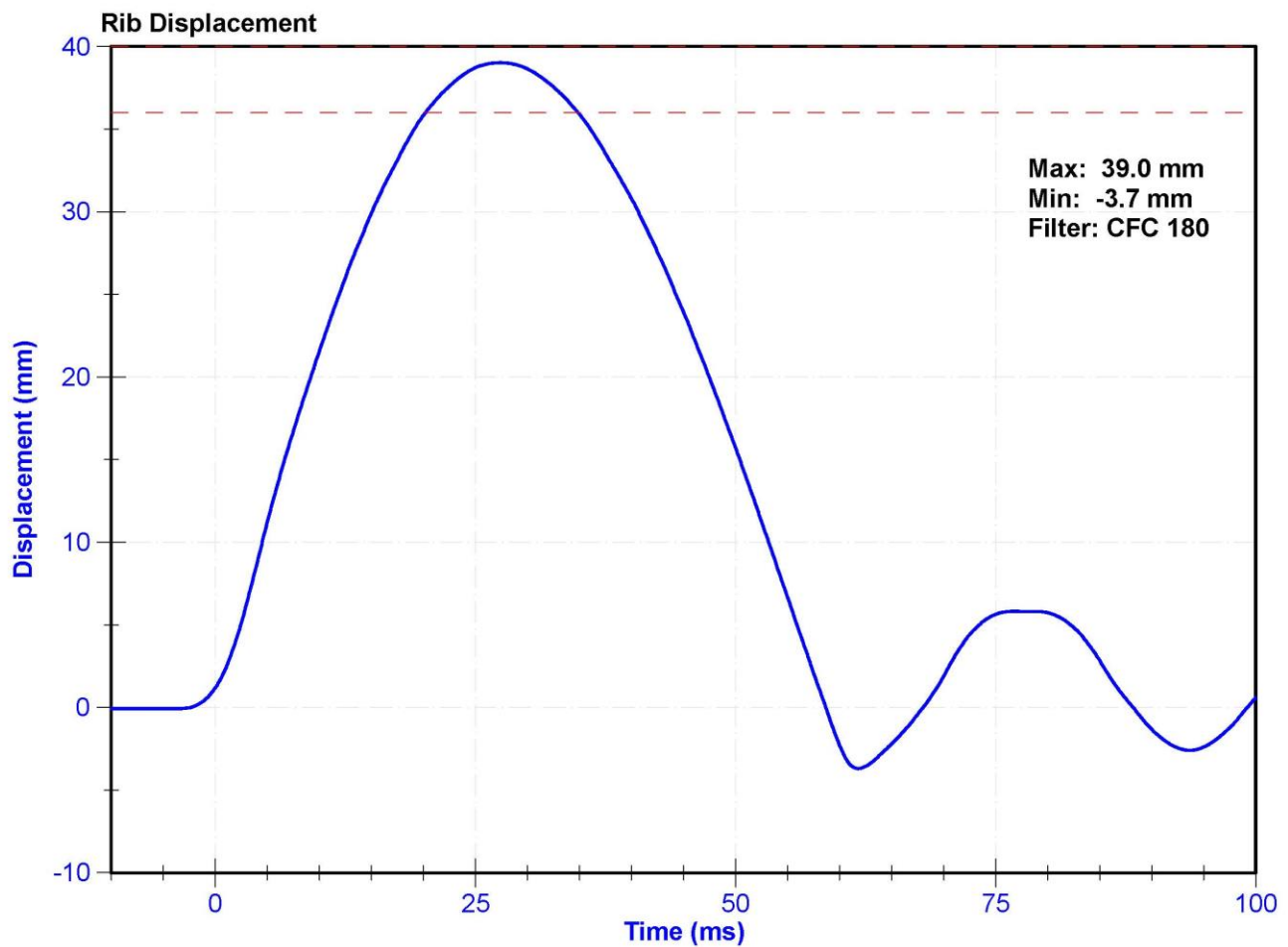
ATD Manufacturer	FTSS	Test Technician	D.Reinhard
ATD Serial Number	DG5348	Laboratory Supervisor	K. Brogan

Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	20.7	Pass
Humidity	10	70	%	50.2	Pass
Rib Displacement	36	40	mm	39.0	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Rib Potentiometer	Honeywell MLT-38000203	DS-269GFE	11/27/2018	11/27/2019



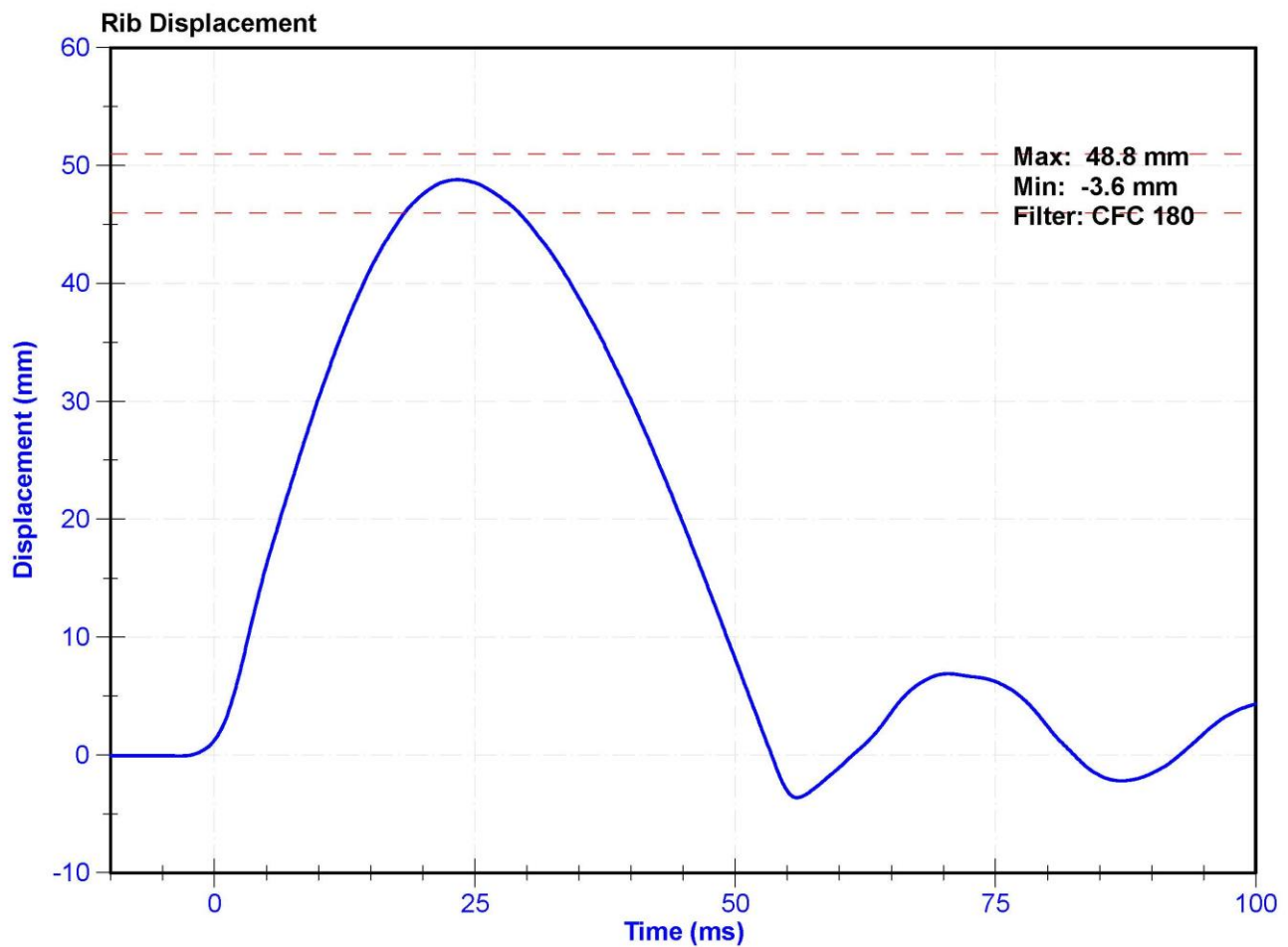
ATD Manufacturer	FTSS	Test Technician	D.Reinhard
ATD Serial Number	DG5348	Laboratory Supervisor	K. Brogan

Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	20.7	Pass
Humidity	10	70	%	50.3	Pass
Rib Displacement	46	51	mm	48.8	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Rib Potentiometer	Honeywell MLT-38000203	DS-269GFE	11/27/2018	11/27/2019



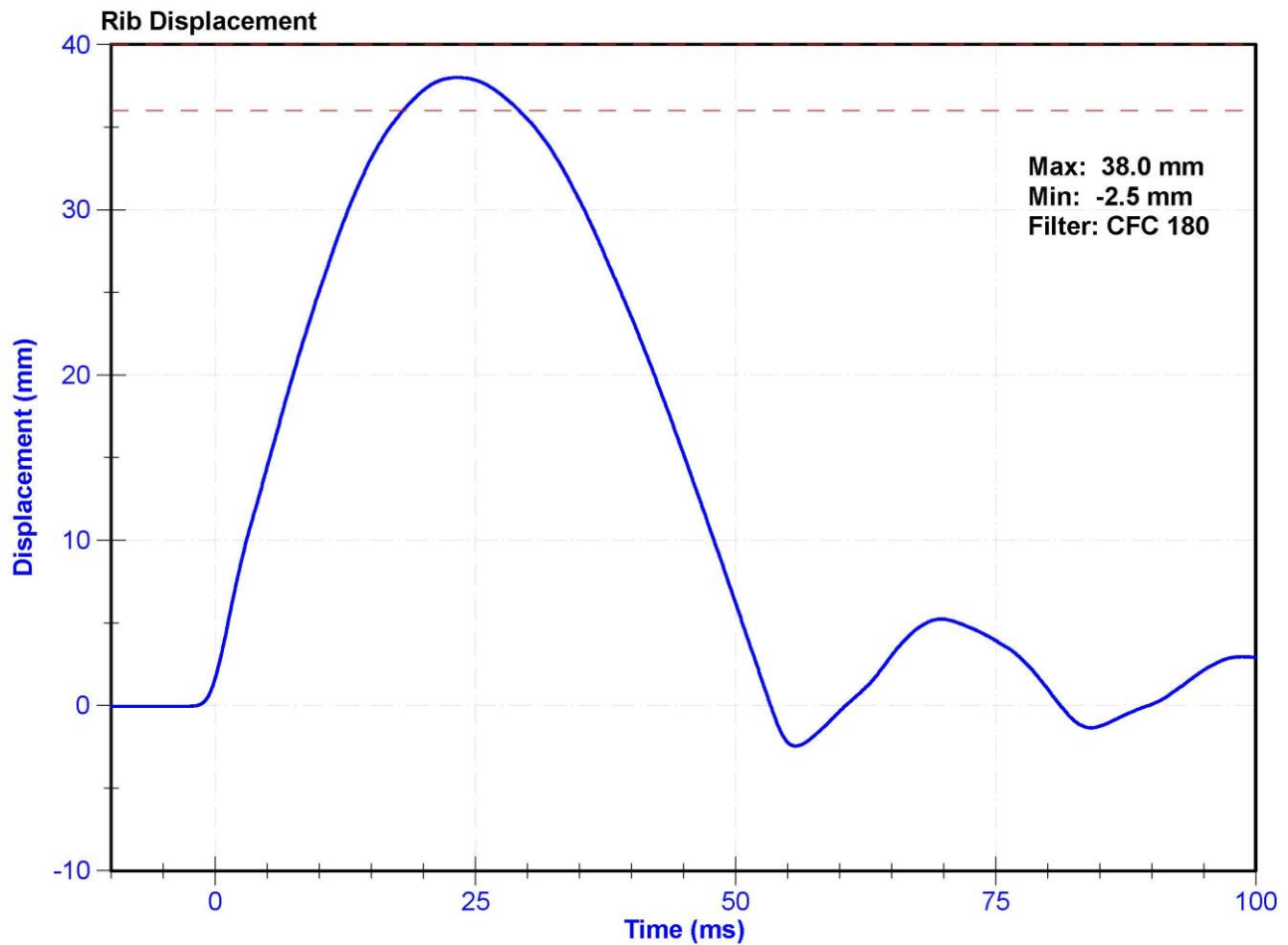
ATD Manufacturer	FTSS	Test Technician	D.Reinhard
ATD Serial Number	DG5348	Laboratory Supervisor	K. Brogan

Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	20.9	Pass
Humidity	10	70	%	50.2	Pass
Rib Displacement	36	40	mm	38.0	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Rib Potentiometer	Honeywell MLT-38000203	DS-270GFE	11/27/2018	11/27/2019



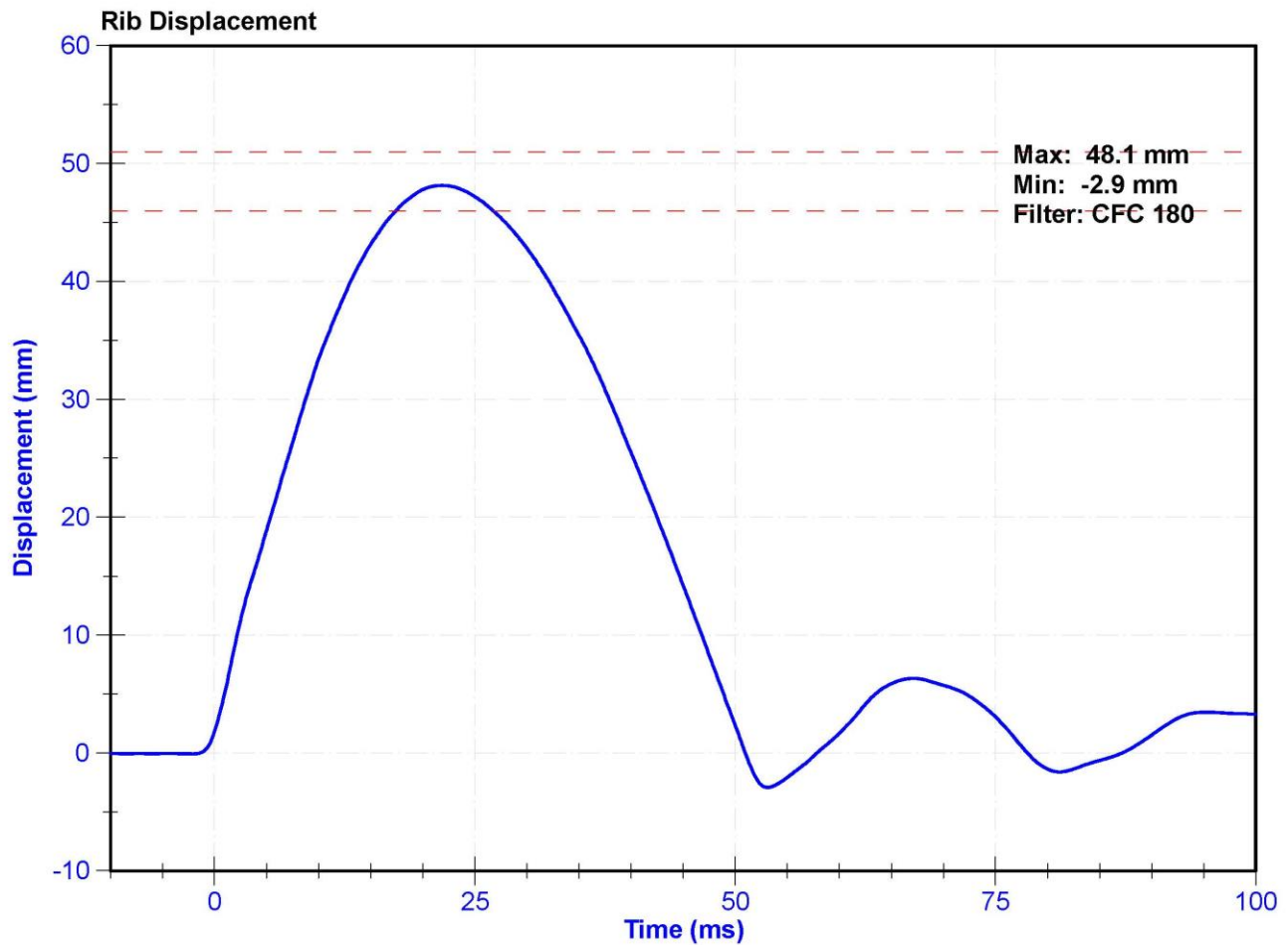
ATD Manufacturer	FTSS	Test Technician	D.Reinhard
ATD Serial Number	DG5348	Laboratory Supervisor	K. Brogan

Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	20.8	Pass
Humidity	10	70	%	50.2	Pass
Rib Displacement	46	51	mm	48.1	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Rib Potentiometer	Honeywell MLT-38000203	DS-270GFE	11/27/2018	11/27/2019



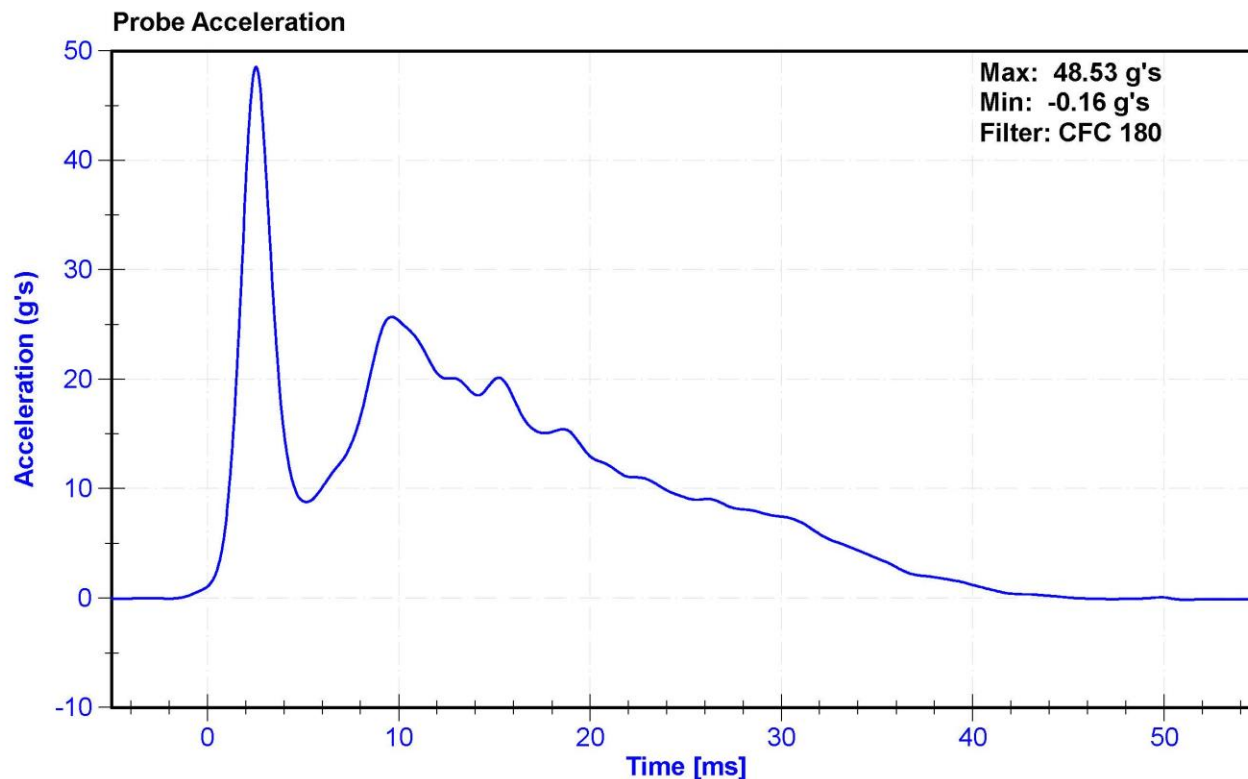
ATD Manufacturer	FTSS	Test Technician	K. Dutton
ATD Serial Number	DG5348	Laboratory Supervisor	K. Brogan

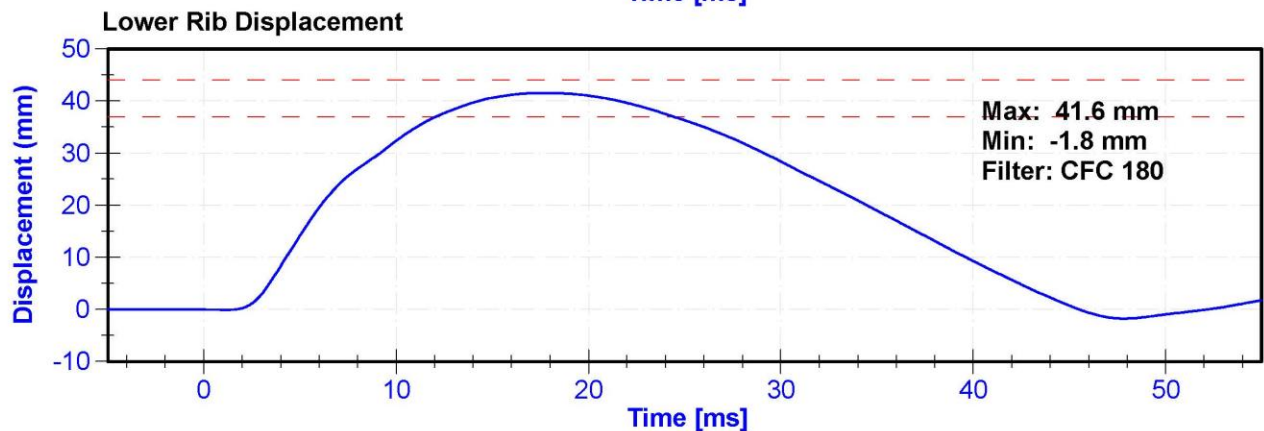
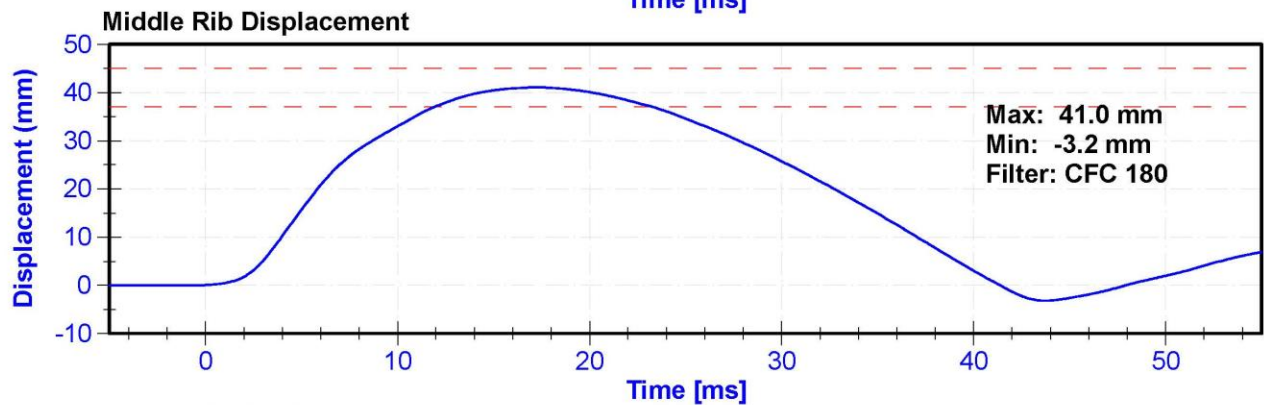
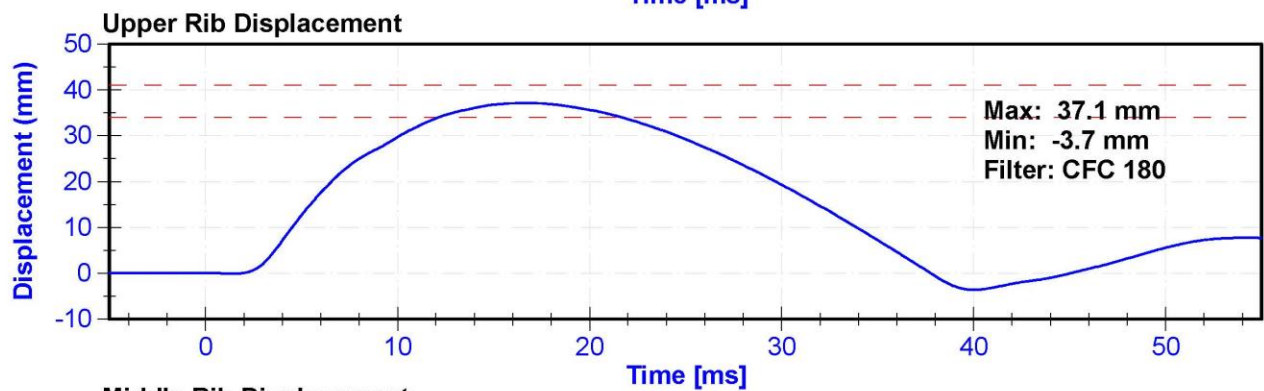
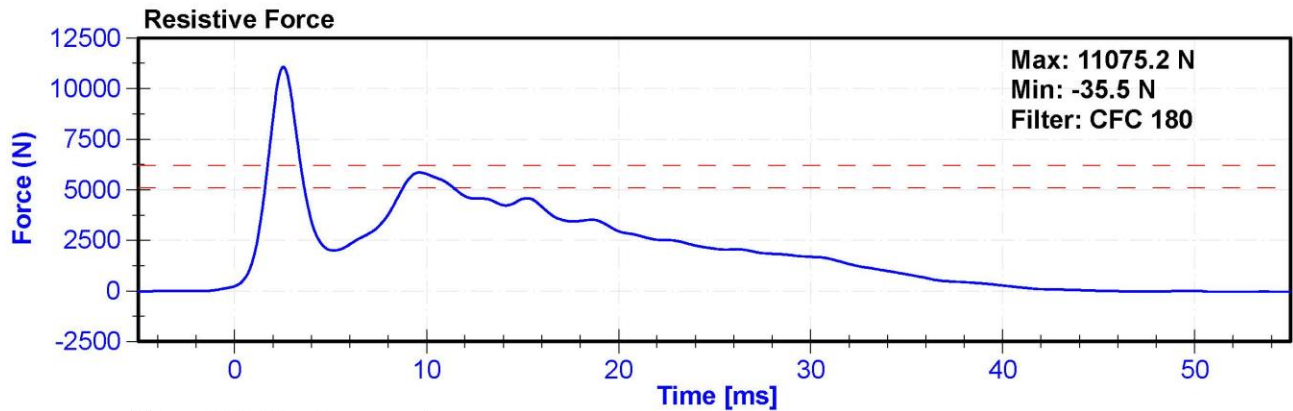
Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	21.1	Pass
Humidity	10	70	%	39.4	Pass
Velocity	5.4	5.6	m/s	5.57	Pass
Resistive Force after 6ms	5100	6200	N	5860.6	Pass
Upper Thorax Rib Deflection	34	41	mm	37.1	Pass
Mid Thorax Rib Deflection	37	45	mm	41.0	Pass
Lower Thorax Rib Deflection	37	44	mm	41.6	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Probe Accelerometer	MSI 64C-2000	A260487	2/21/2019	8/22/2019
Upper Thorax Rib Potentiometer	Honeywell MLT-38000203	DS-268GFE	11/27/2018	11/27/2019
Middle Thorax Rib Potentiometer	Honeywell MLT-38000203	DS-269GFE	11/27/2018	11/27/2019
Lower Thorax Rib Potentiometer	Honeywell MLT-38000203	DS-270GFE	11/27/2018	11/27/2019





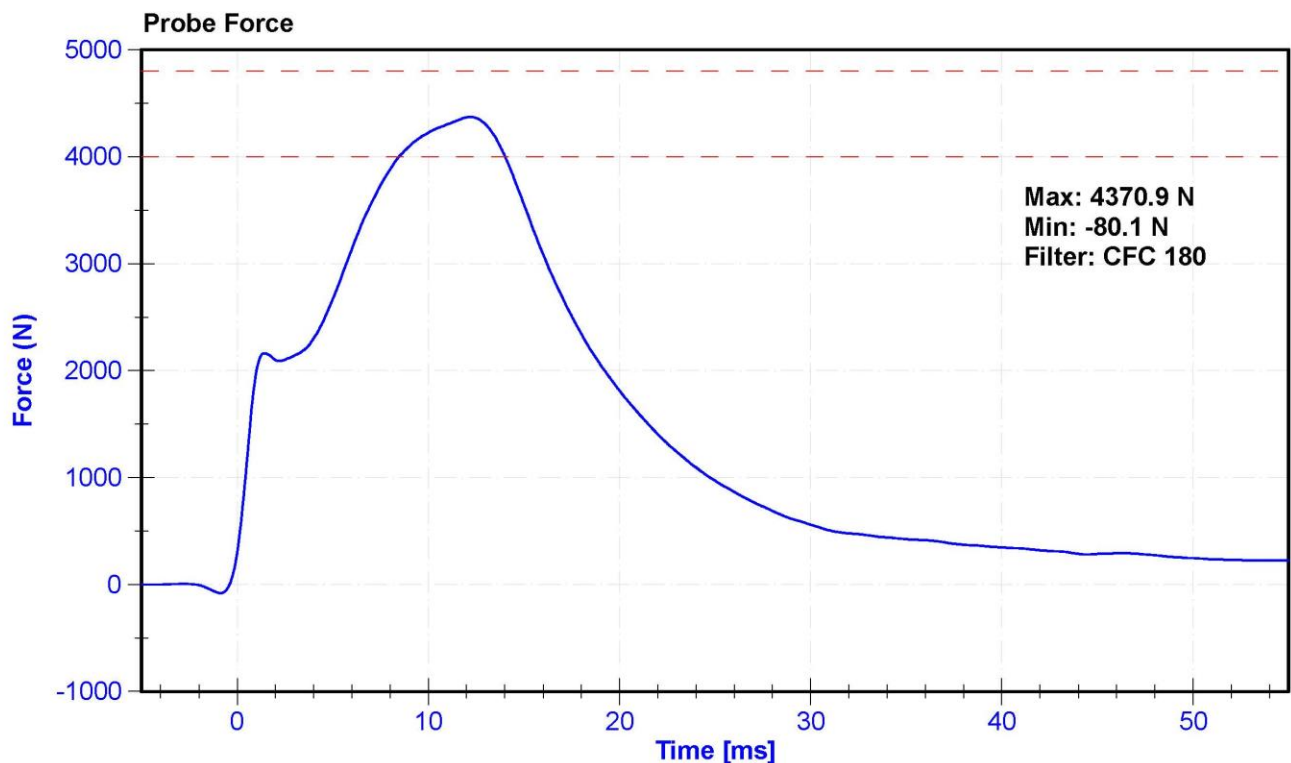
ATD Manufacturer	FTSS	Test Technician	K. Dutton
ATD Serial Number	DG5348	Laboratory Supervisor	K. Brogan

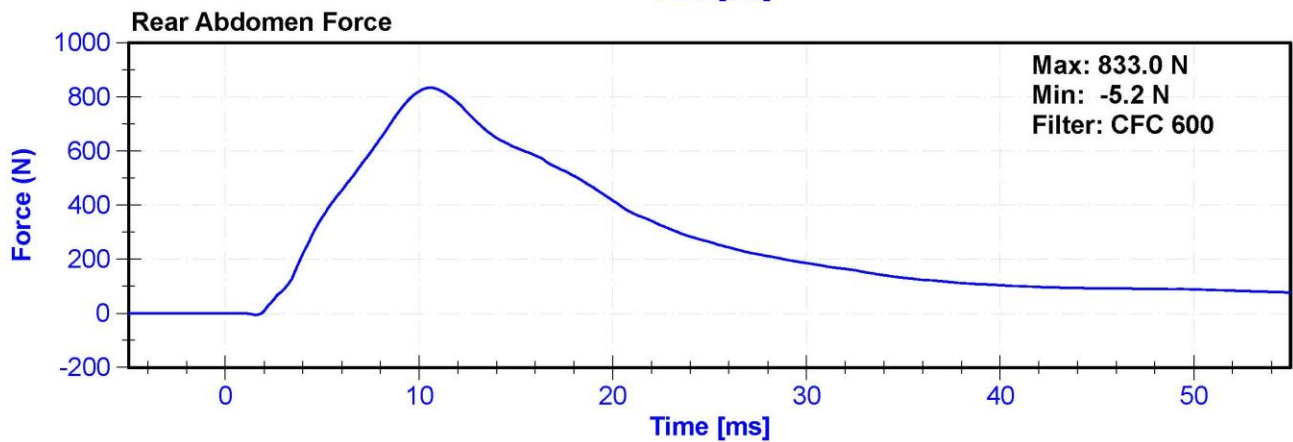
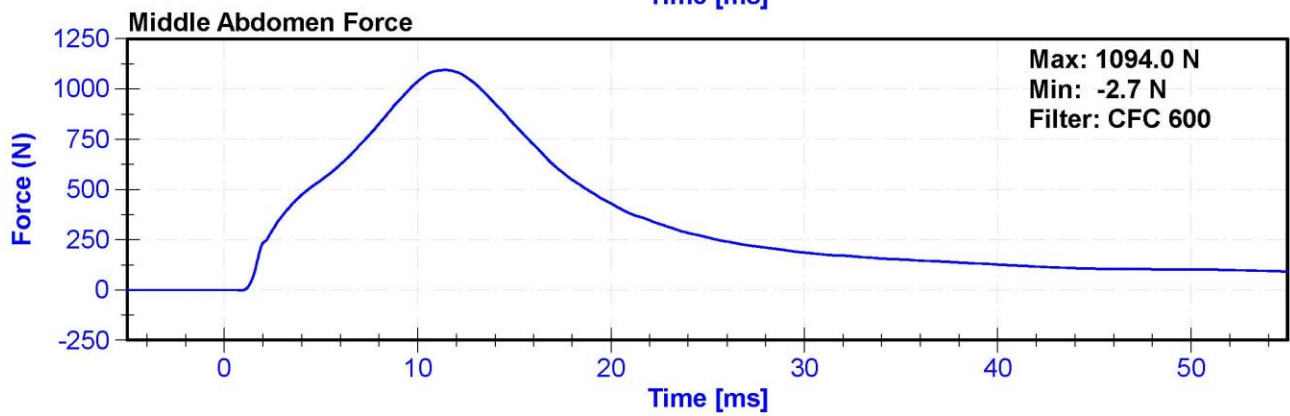
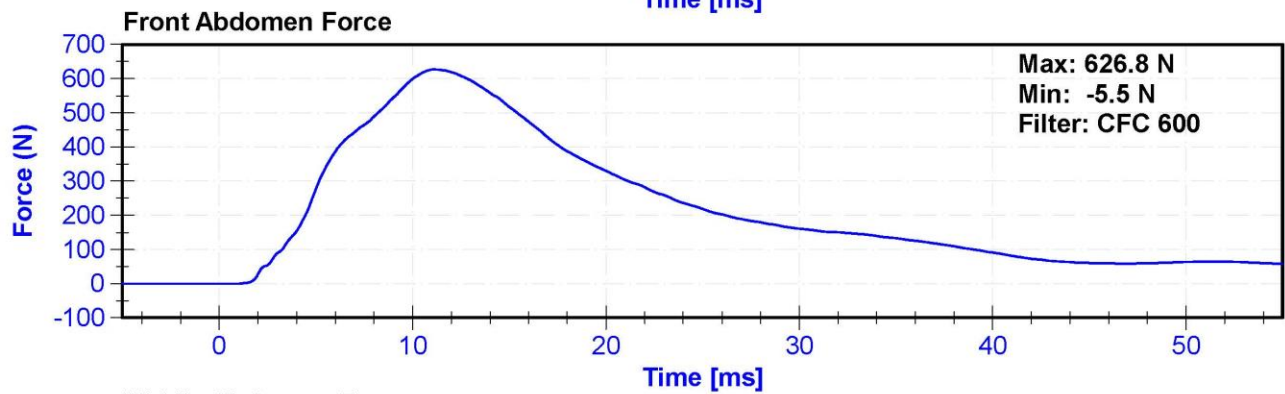
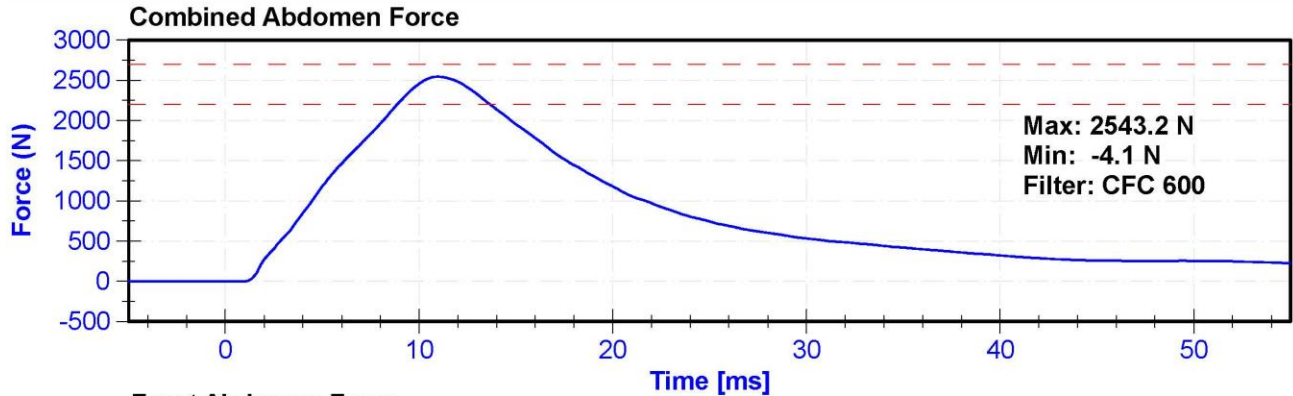
Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	21.2	Pass
Humidity	10	70	%	38.4	Pass
Velocity	3.9	4.1	m/s	4.08	Pass
Combined Abdomen Force	2200	2700	N	2543.2	Pass
Time at Peak Abdomen Force	10.0	12.3	ms	10.95	Pass
Resistive Probe Force	4000	4800	N	4370.9	Pass
Time at Peak Resistive Force	10.6	13.0	ms	12.20	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	MSI 64C-2000	A260487	2/21/2019	8/22/2019
Front Abdomen Load Cell	FTSS 2631	LC-1509	10/4/2018	10/4/2019
Middle Abdomen Load Cell	DENTON 2631	LC-1508	10/4/2018	10/4/2019
Rear Abdomen Load Cell	FTSS 2631	LC-1507	10/4/2018	10/4/2019







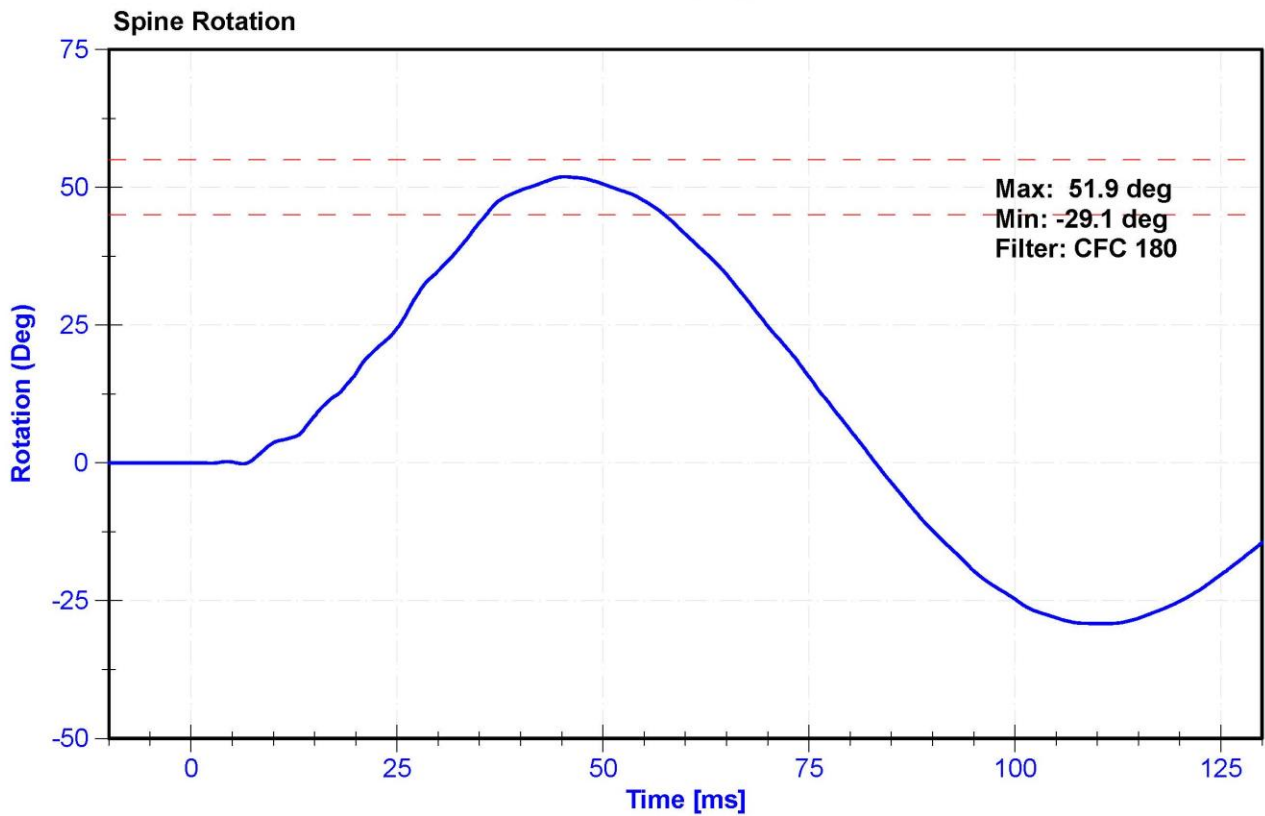
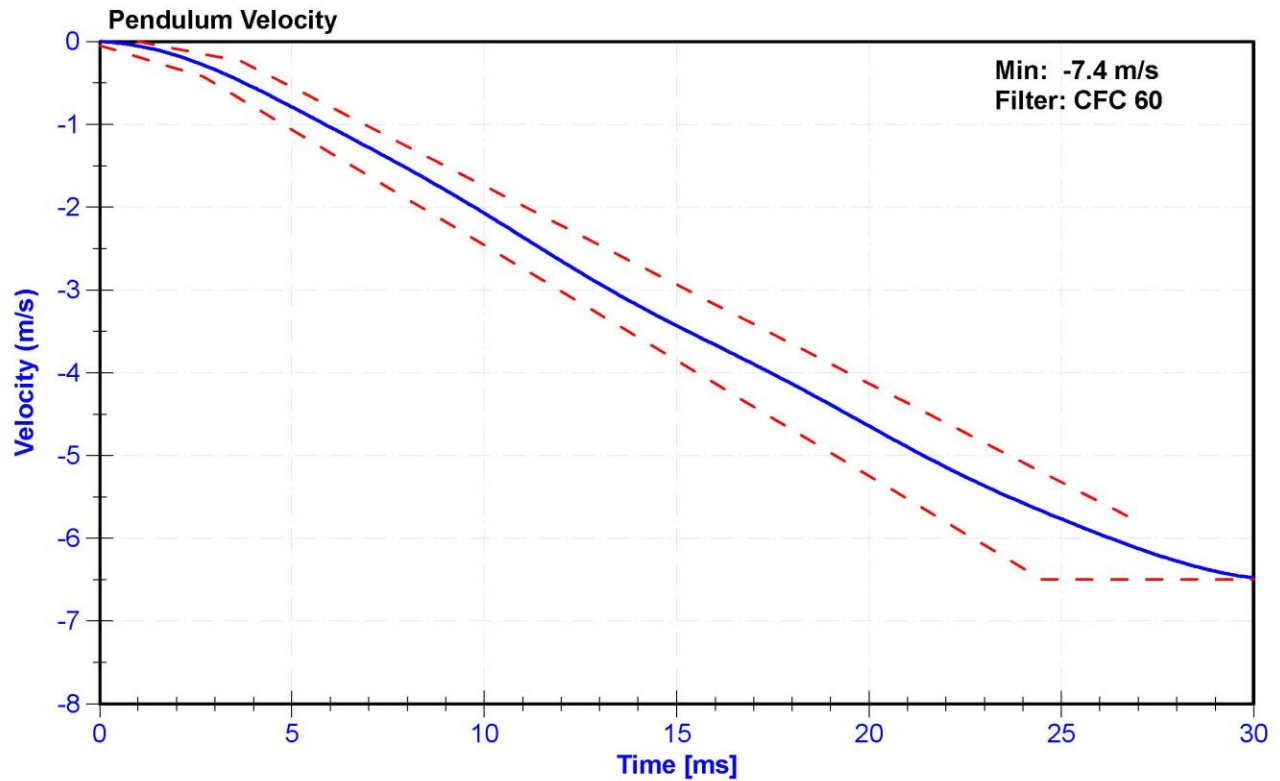
ATD Manufacturer	FTSS	Test Technician	D.Reinhard
ATD Serial Number	DG5348	Laboratory Supervisor	K. Brogan

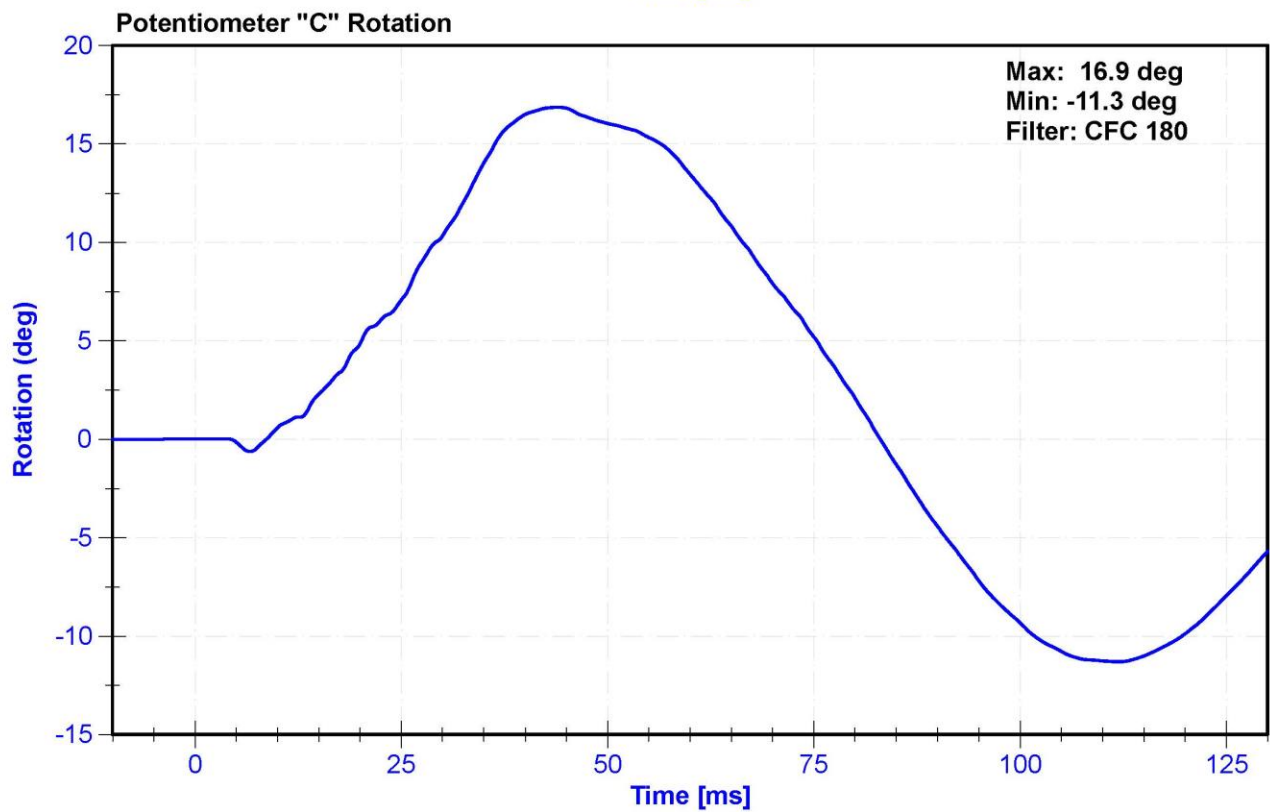
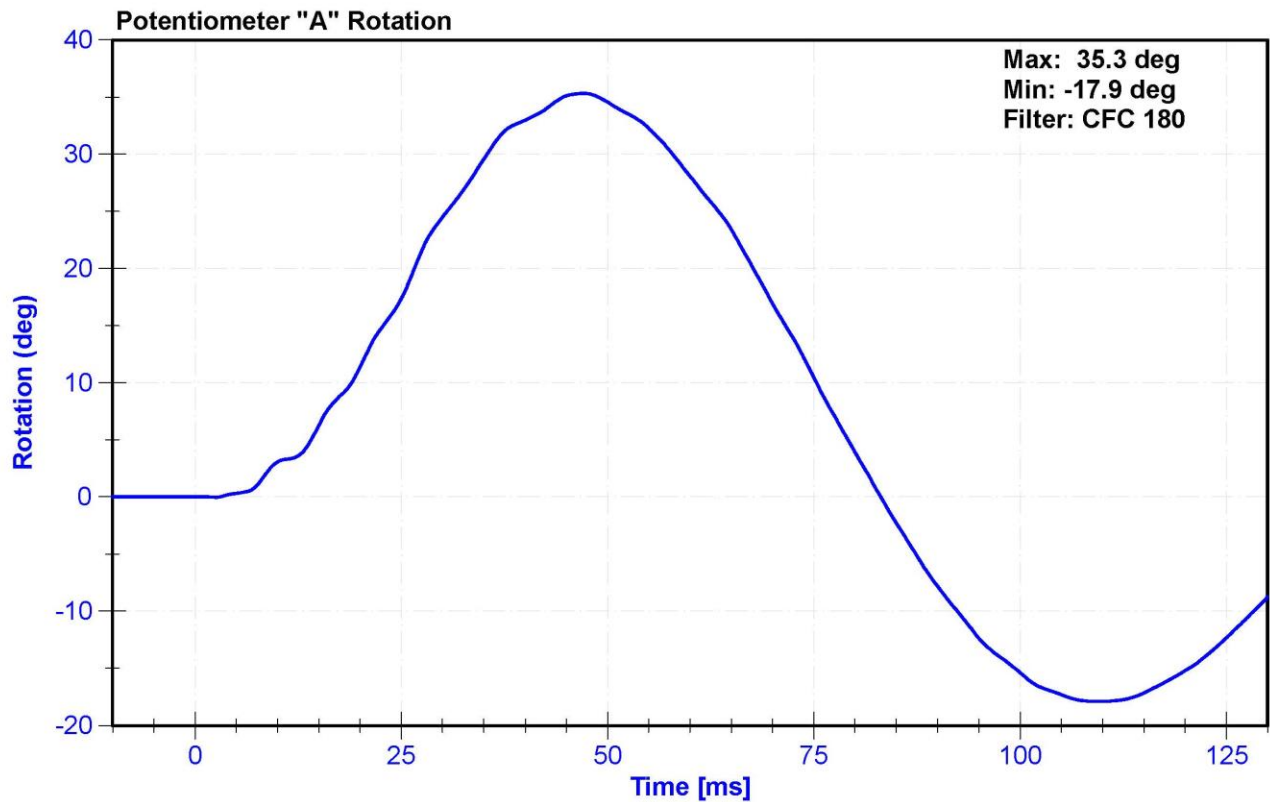
Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	21.6	Pass
Humidity	10	70	%	38.4	Pass
Velocity	5.95	6.15	m/s	6.046	Pass
Lateral Spine Rotation	45	55	deg	51.9	Pass
Time at Maximum Rotation	39	53	ms	45.3	Pass
Time of Decay to Zero Degrees	37	57	ms	37.8	Pass
Pulse within Corridor?	-	-	-		

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	ENDEVCO 7231CT	AC-AH5M9 Pend	1/29/2019	1/29/2020
Pendulum "A" Potentiometer	SP22G	DS-094	10/31/2018	10/31/2019
Condyle "B" Potentiometer	SP22G	DS-095	10/31/2018	10/31/2019





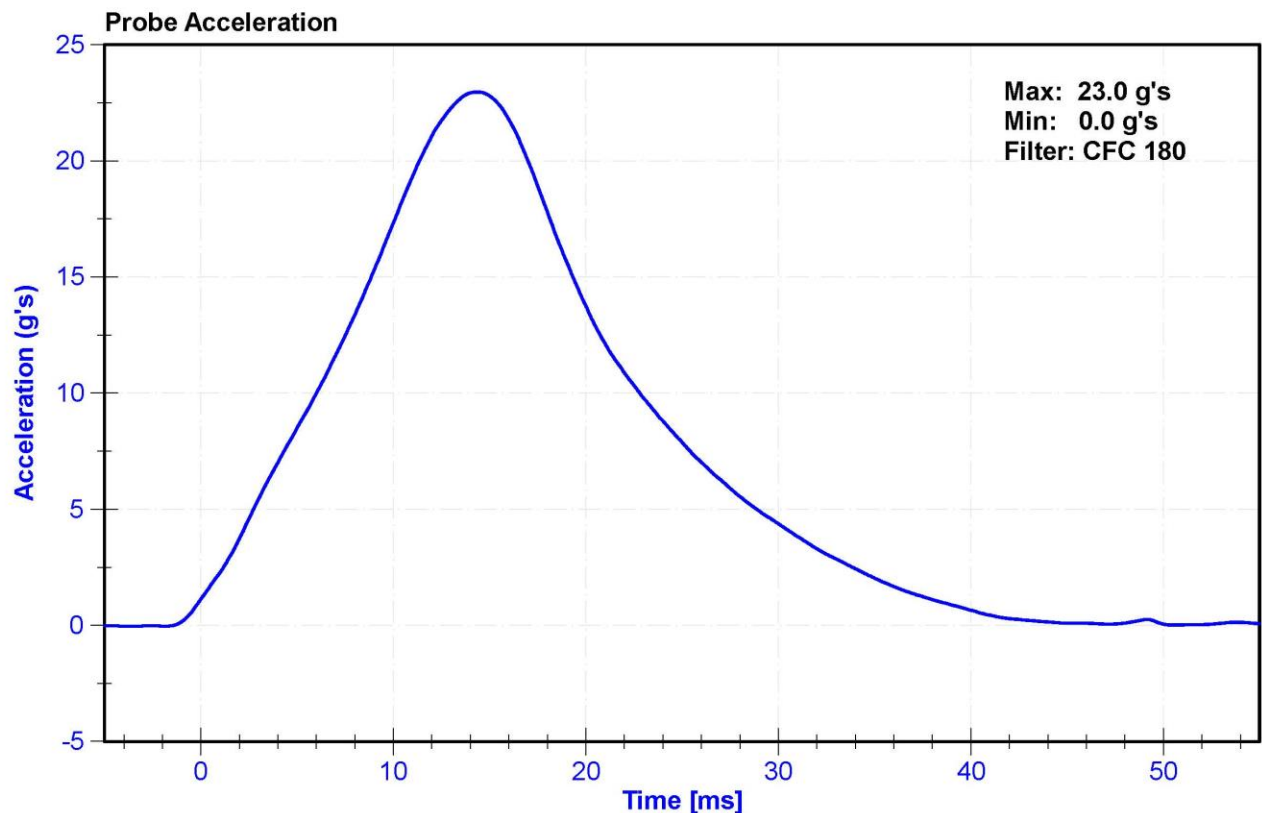
ATD Manufacturer	FTSS	Test Technician	K. Dutton
ATD Serial Number	DG5348	Laboratory Supervisor	K. Brogan

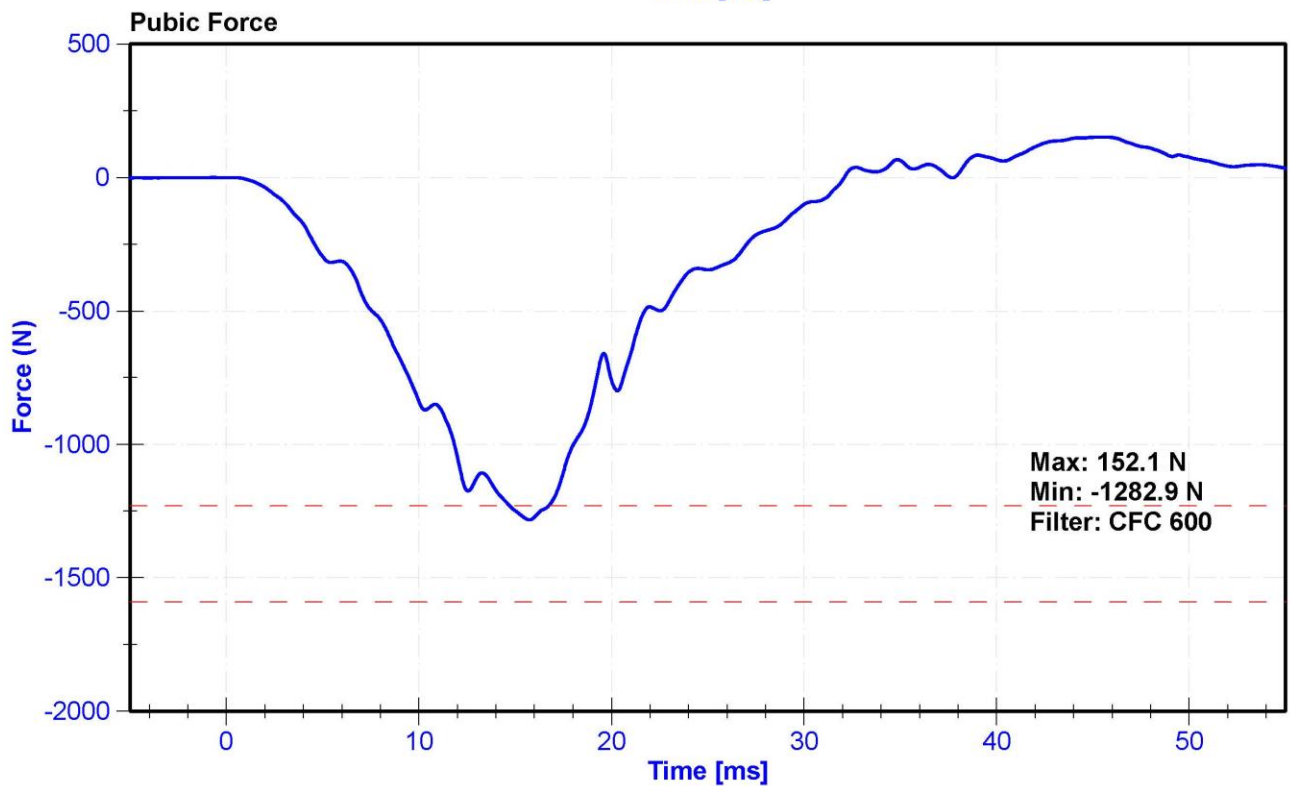
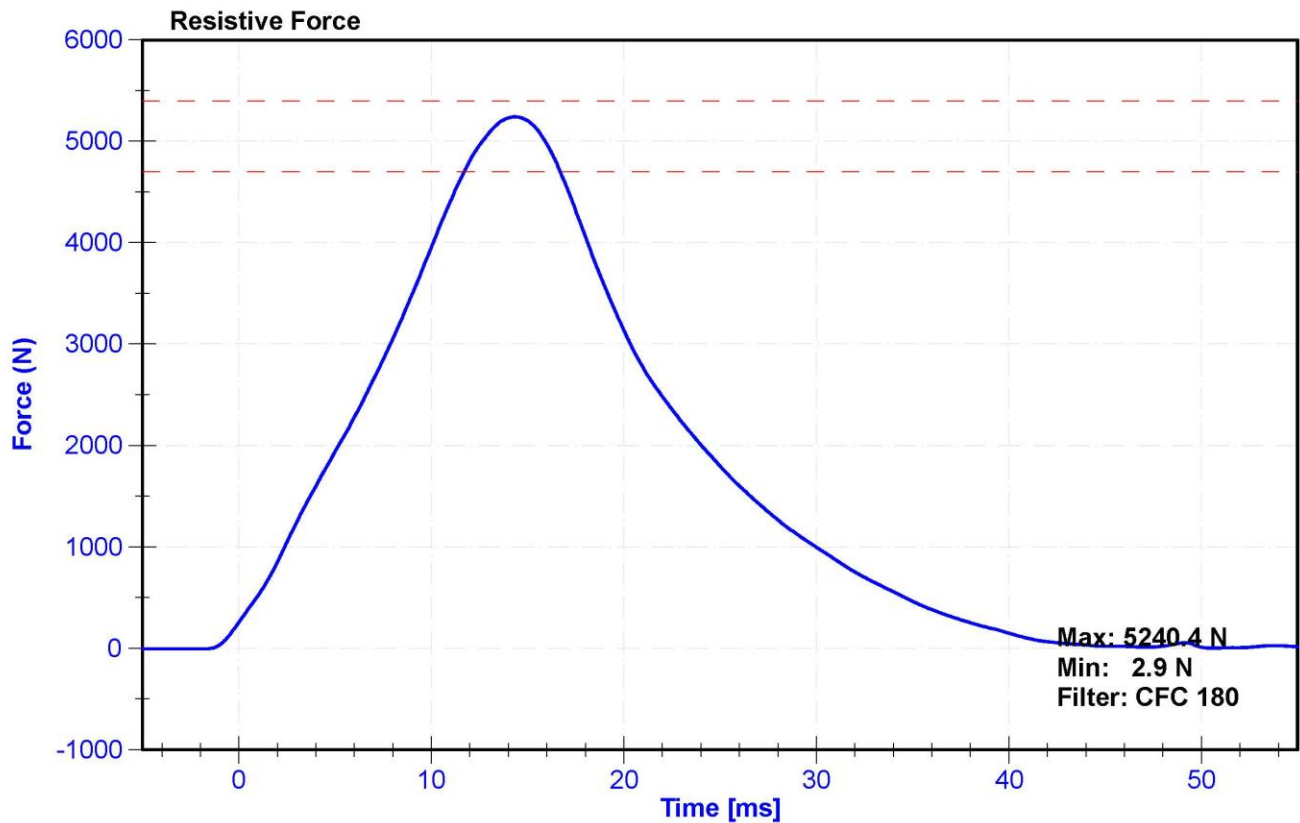
Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	22.0	Pass
Humidity	10	70	%	35.0	Pass
Velocity	4.2	4.4	m/s	4.31	Pass
Resistive Force	4700	5400	N	5240.4	Pass
Time at Peak Resistive Force	11.8	16.1	ms	14.35	Pass
Pubic Force	-1590	-1230	N	-1282.9	Pass
Time at Peak Pubic Force	12.2	17.0	ms	15.75	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	MSI 64C-2000	A260487	2/21/2019	8/22/2019
Pubic Load Cell	FTSS 3096	LC-458	10/4/2018	10/4/2019





POST-TEST DUMMY PERFORMANCE CALIBRATION TEST DATA
(Subpart U, ES-2re)

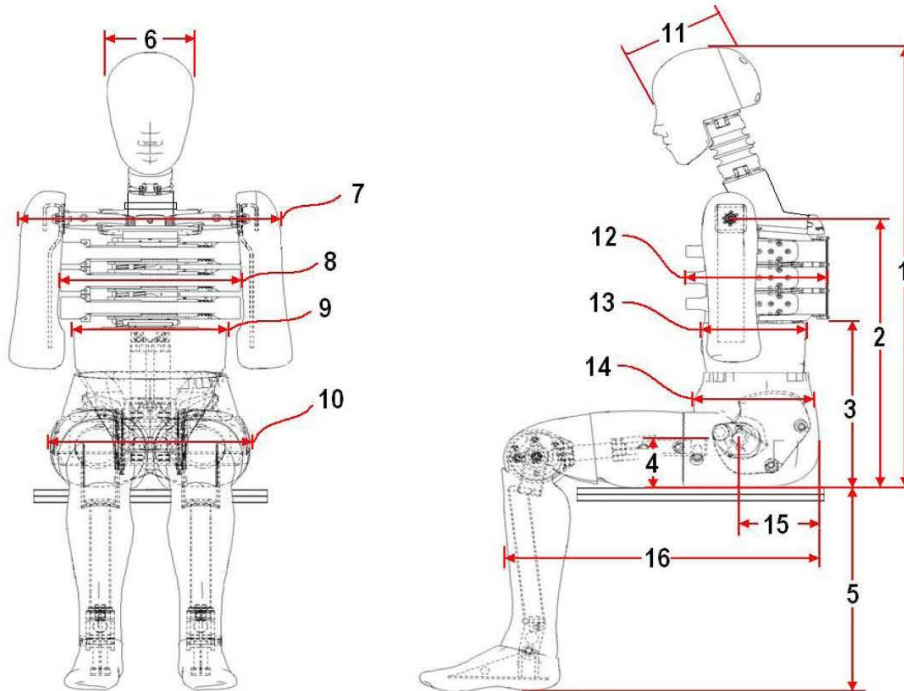


External Measurements - EuroSID-2re

Technician: K. Dutton

Date: 5/16/2019

Dummy Serial Number: DG5348



FRONT VIEW

SIDE VIEW

Dim. No.	Description	Specification (mm)		Result (mm)	Pass/Fail
1	Sitting Height	900	918	915	Pass
2	Seat to Shoulder Joint	558	572	566	Pass
3	Seat to Lower Face of Thoracic Spine Box	346	356	353	Pass
4	Seat to Hip Joint (center of bolt)	97	103	100	Pass
5	Sole to Seat, Sitting	333	451	399	Pass
6	Head Width	152	158	155	Pass
7	Shoulder/Arm Width	461	479	473	Pass
8	Thorax Width	322	332	324	Pass
9	Abdomen Width	273	287	280	Pass
10	Pelvis Lap Width	359	373	366	Pass
11	Head Depth	196	206	202	Pass
12	Thorax Depth	262	272	268	Pass
13	Abdomen Depth	194	204	200	Pass
14	Pelvis Depth	235	245	242	Pass
15	Back of Buttocks to Hip Joint (center of bolt)	150	160	153	Pass
16	Back of Buttocks to Front Knee	597	615	604	Pass

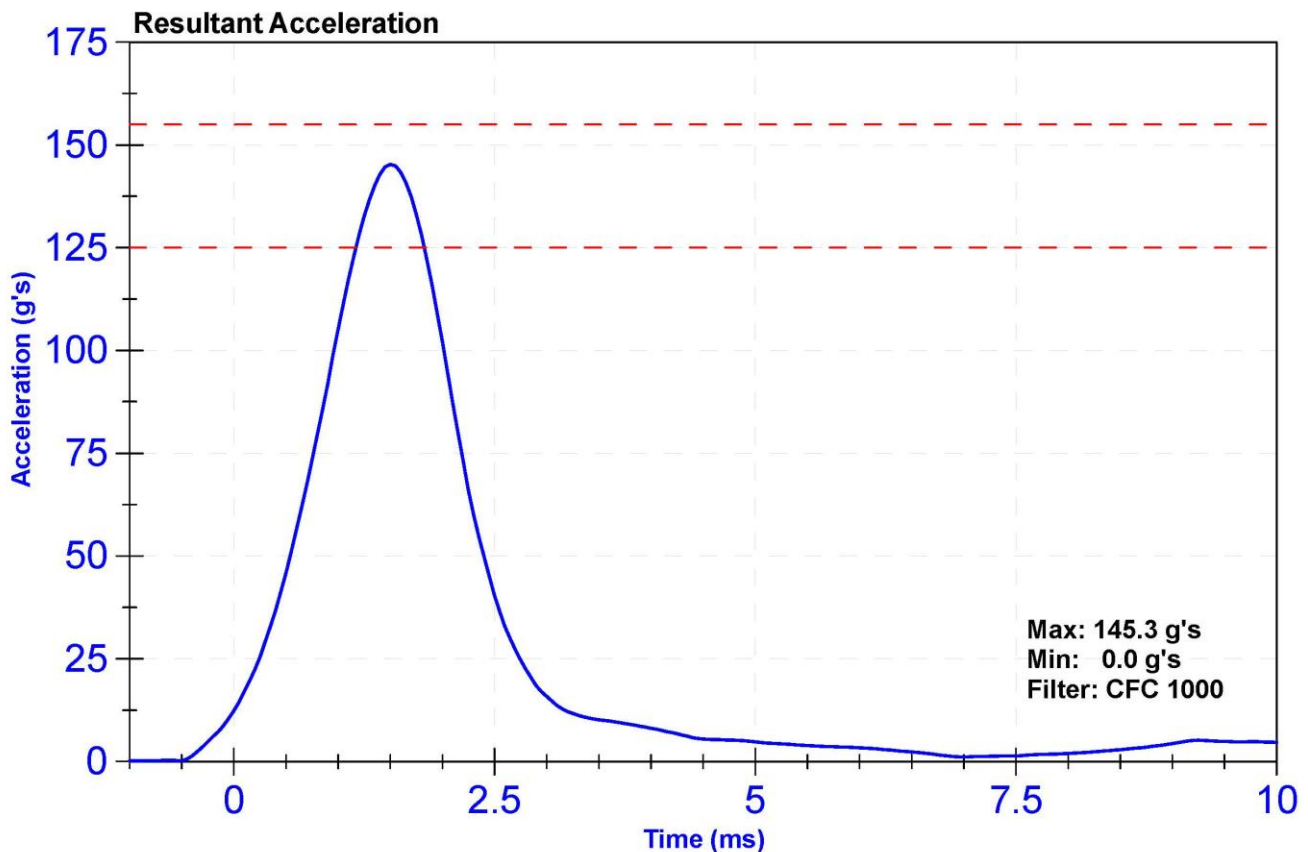
ATD Manufacturer	FTSS	Test Technician	D.Reinhard
ATD Serial Number	DG5348	Laboratory Supervisor	K. Brogan

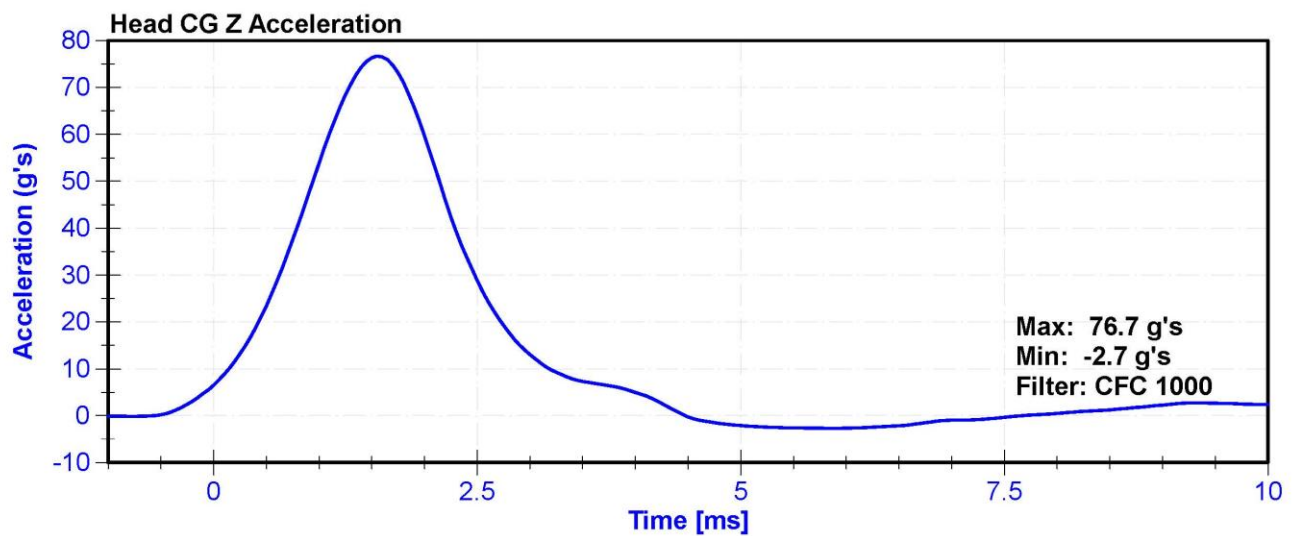
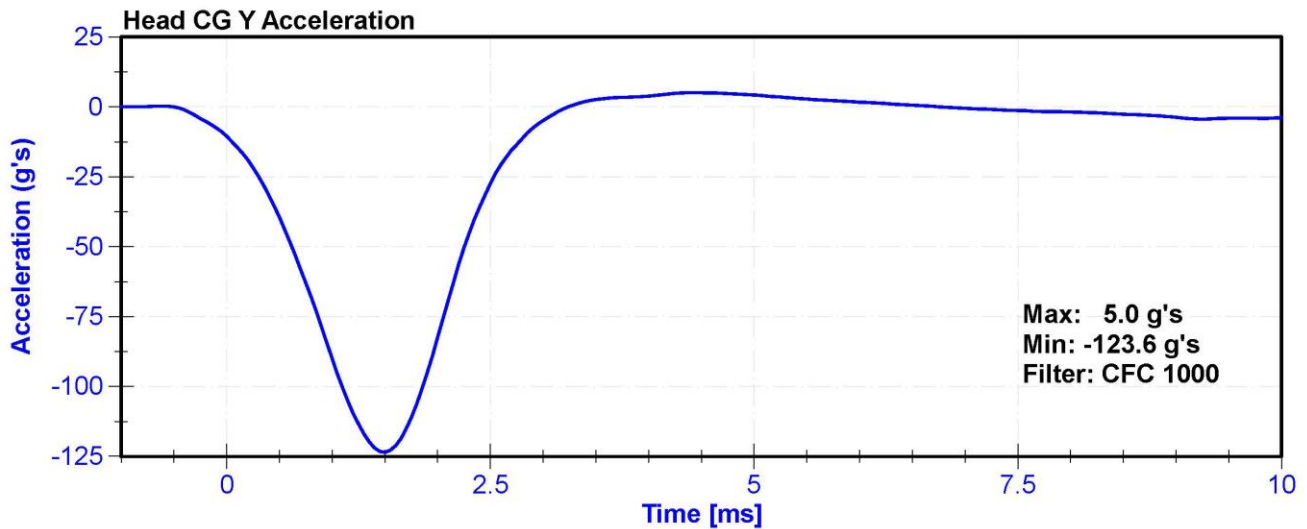
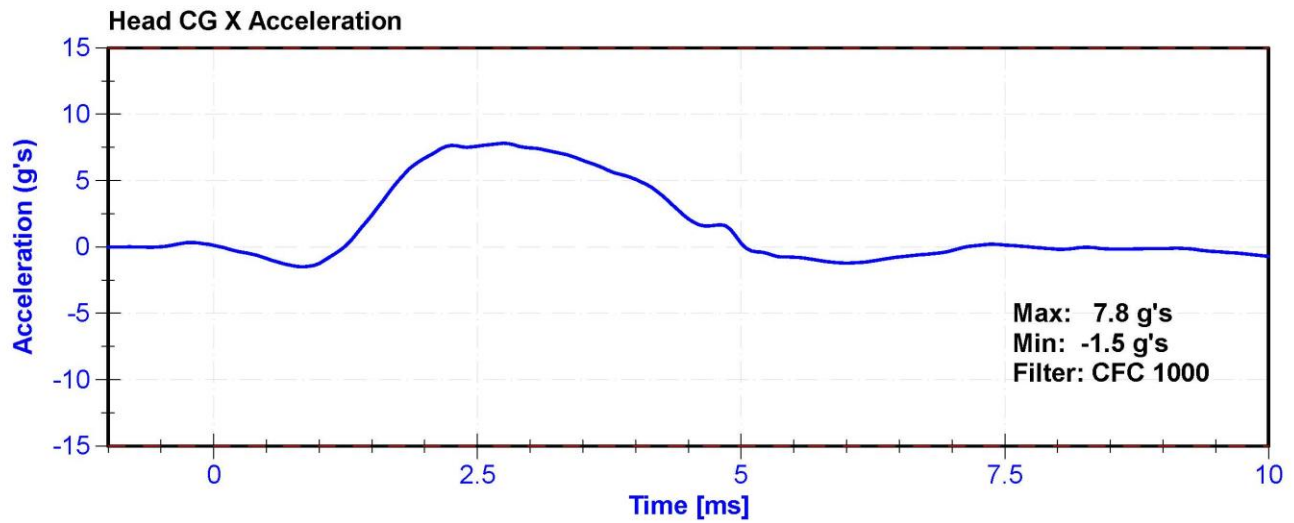
Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	20.9	Pass
Humidity	10	70	%	48.5	Pass
Resultant Acceleration	125	155	g's	145.3	Pass
Oscillation	0	15	%	3.55	Pass
Fore-Aft Acceleration	-15	15	g's	7.8	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
X Accelerometer	ENDEVCO 7264CT	AC-P58757	5/9/2019	11/7/2019
Y Accelerometer	ENDEVCO 7264CT	AC-P68062	5/7/2019	11/5/2019
Z Accelerometer	ENDEVCO 7264CT	AC-P68066	5/9/2019	11/7/2019





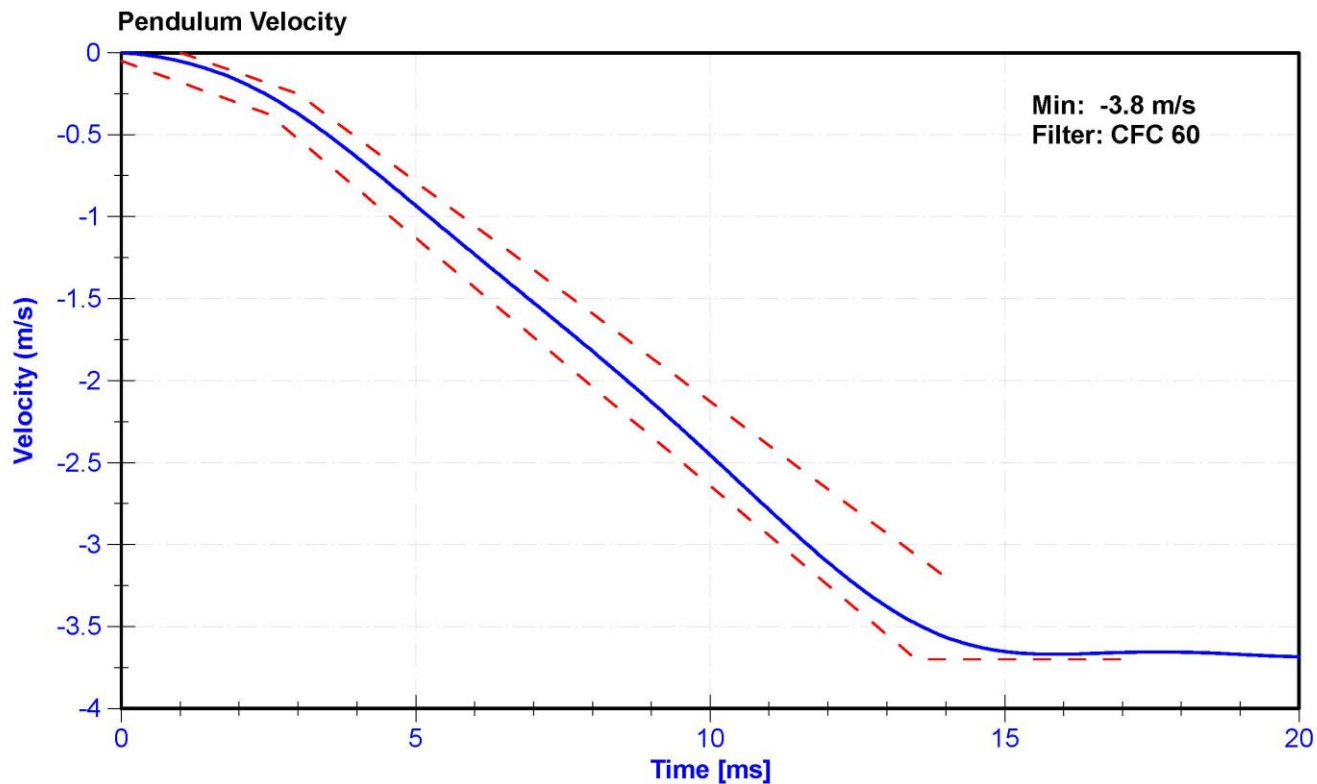
ATD Manufacturer	FTSS	Test Technician	D.Reinhard
ATD Serial Number	DG5348	Laboratory Supervisor	K. Brogan

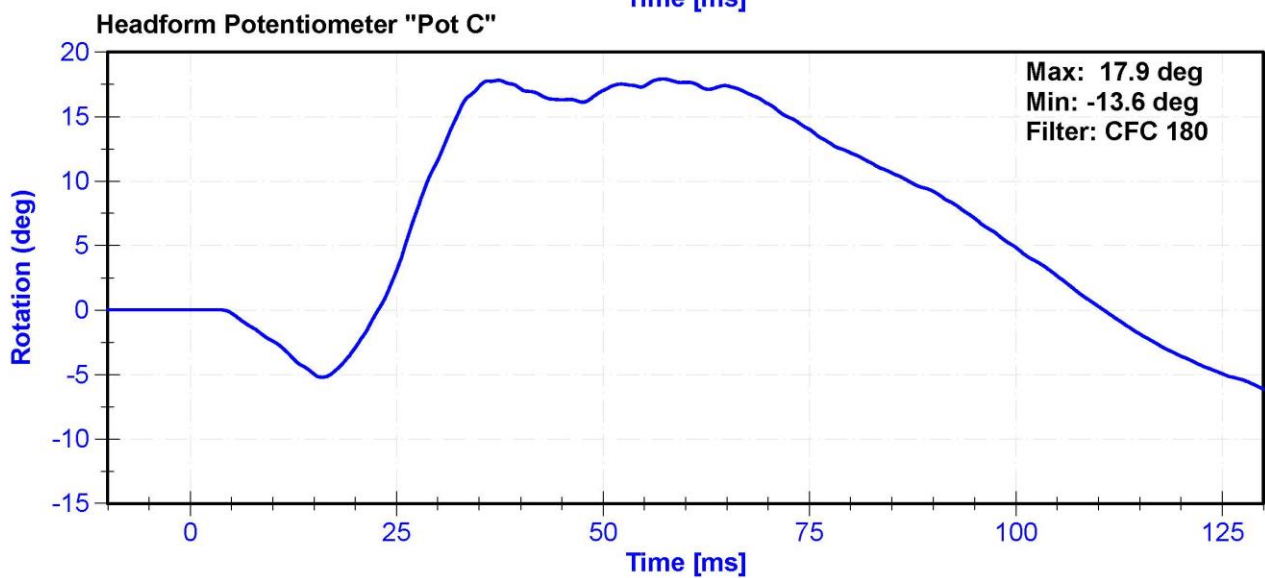
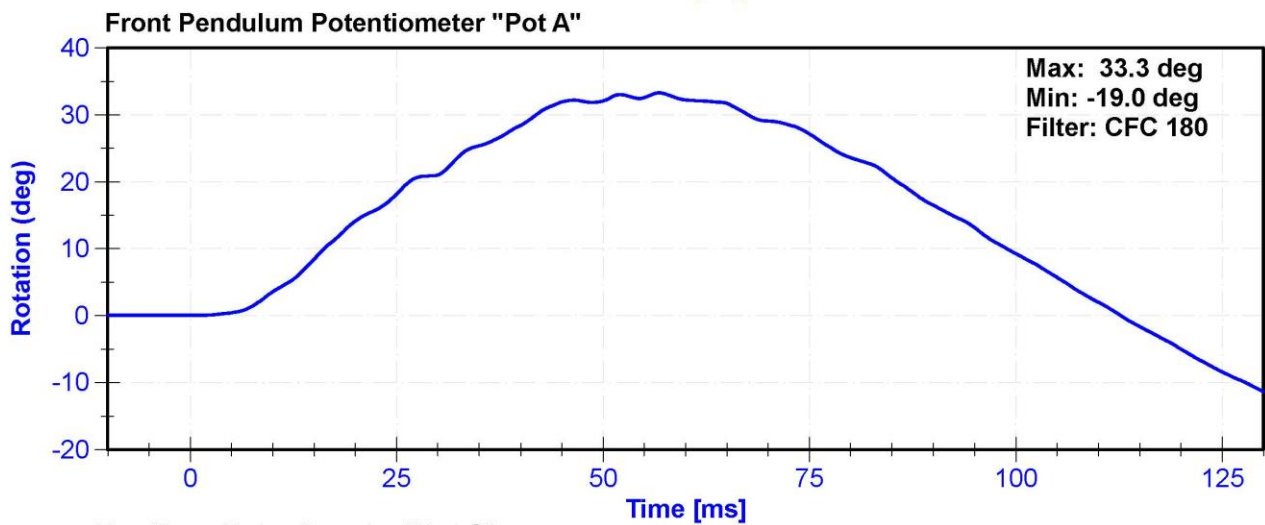
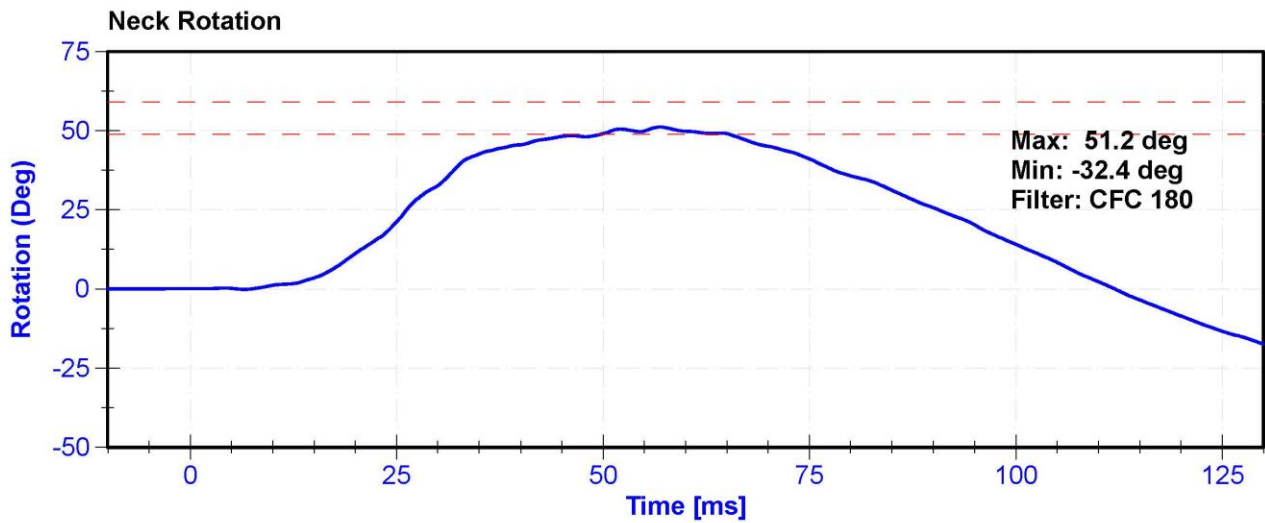
Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	22	Pass
Humidity	10	70	%	46.1	Pass
Velocity	3.3	3.5	m/s	3.38	Pass
Lateral Neck Rotation	49	59	deg	51.2	Pass
Time at Maximum Rotation	54	66	ms	56.9	Pass
Time of Rotation Decay from Maximum	53	88	ms	55.1	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	ENDEVCO 7231CT	AC-AH5M9	1/29/2019	1/29/2020
Front Pendulum Potentiometer	SP22G	DS-094	10/31/2018	10/31/2019
Headform Potentiometer	SP22G	DS-095	10/31/2018	10/31/2019





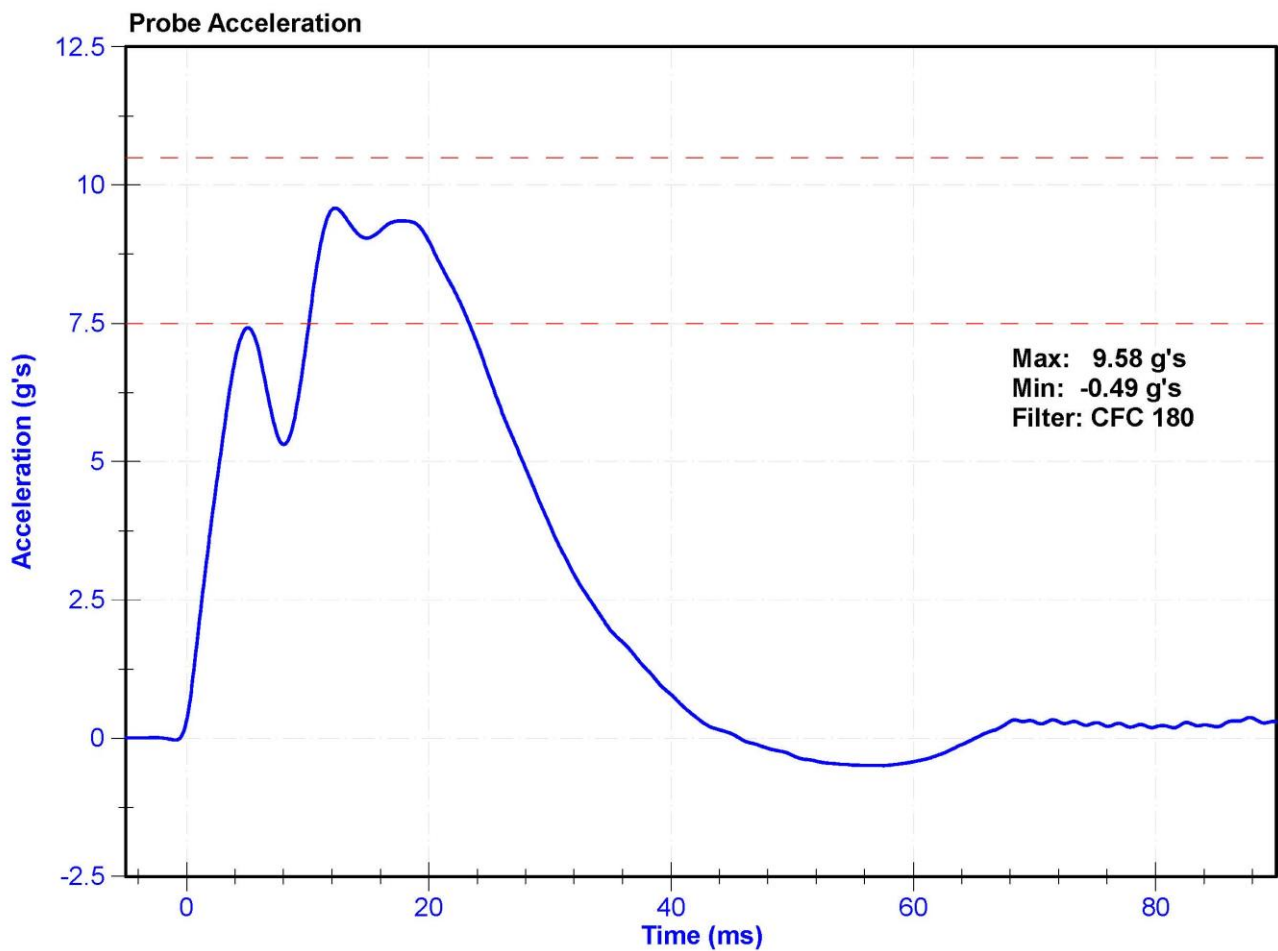
ATD Manufacturer	FTSS	Test Technician	D.Reinhard
ATD Serial Number	DG5348	Laboratory Supervisor	K. Brogan

Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	21.0	Pass
Humidity	10	70	%	62.9	Pass
Velocity	4.2	4.4	m/s	4.39	Pass
Probe Acceleration	7.5	10.5	g's	9.58	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Probe Accelerometer	MSI 64C-2000	A260487	2/21/2019	8/22/2019





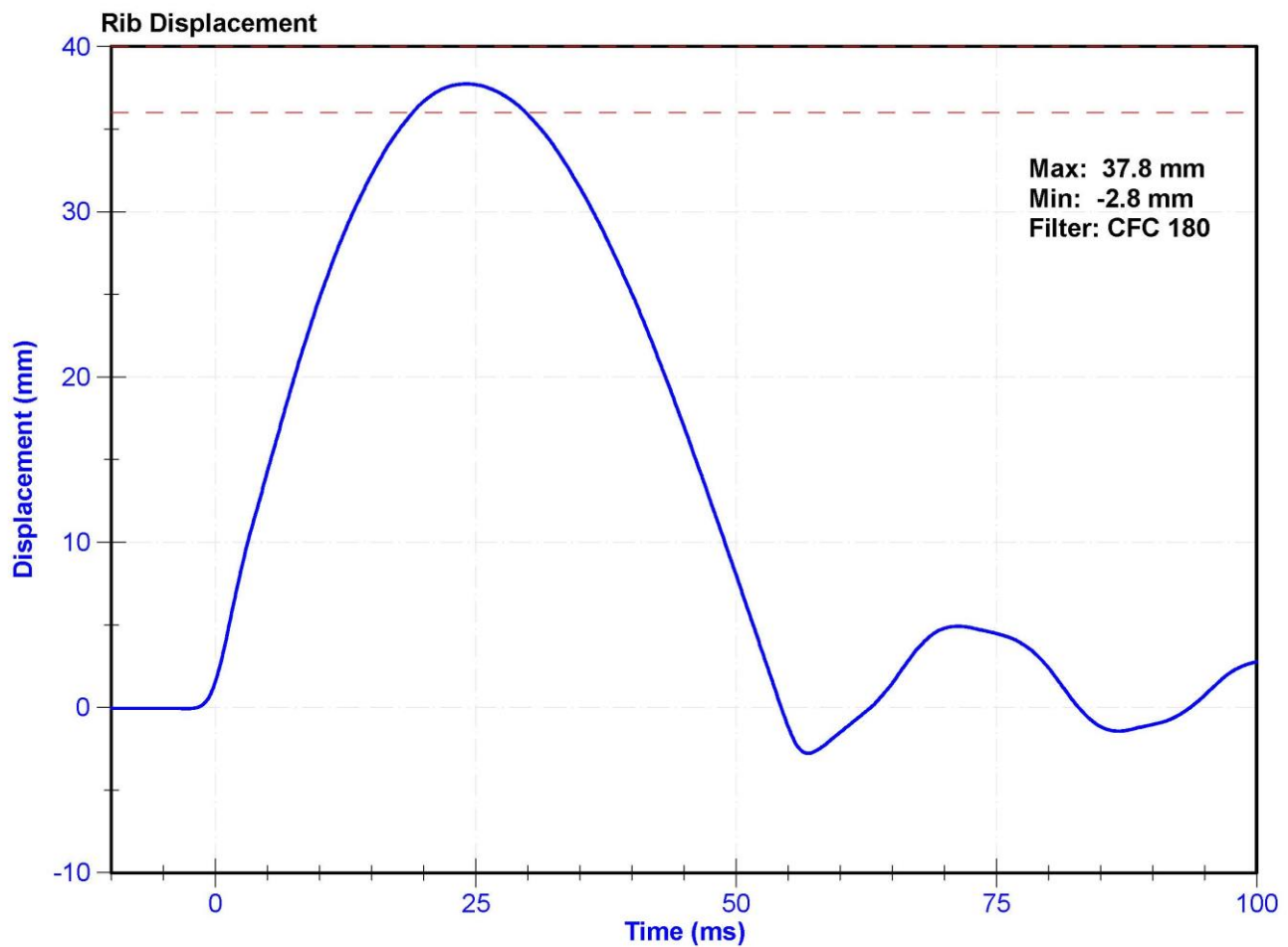
ATD Manufacturer	FTSS	Test Technician	D.Reinhard
ATD Serial Number	DG5348	Laboratory Supervisor	K. Brogan

Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	21.1	Pass
Humidity	10	70	%	44.0	Pass
Rib Displacement	36	40	mm	37.8	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Rib Potentiometer	Honeywell MLT-38000203	DS-268GFE	11/27/2018	11/27/2019



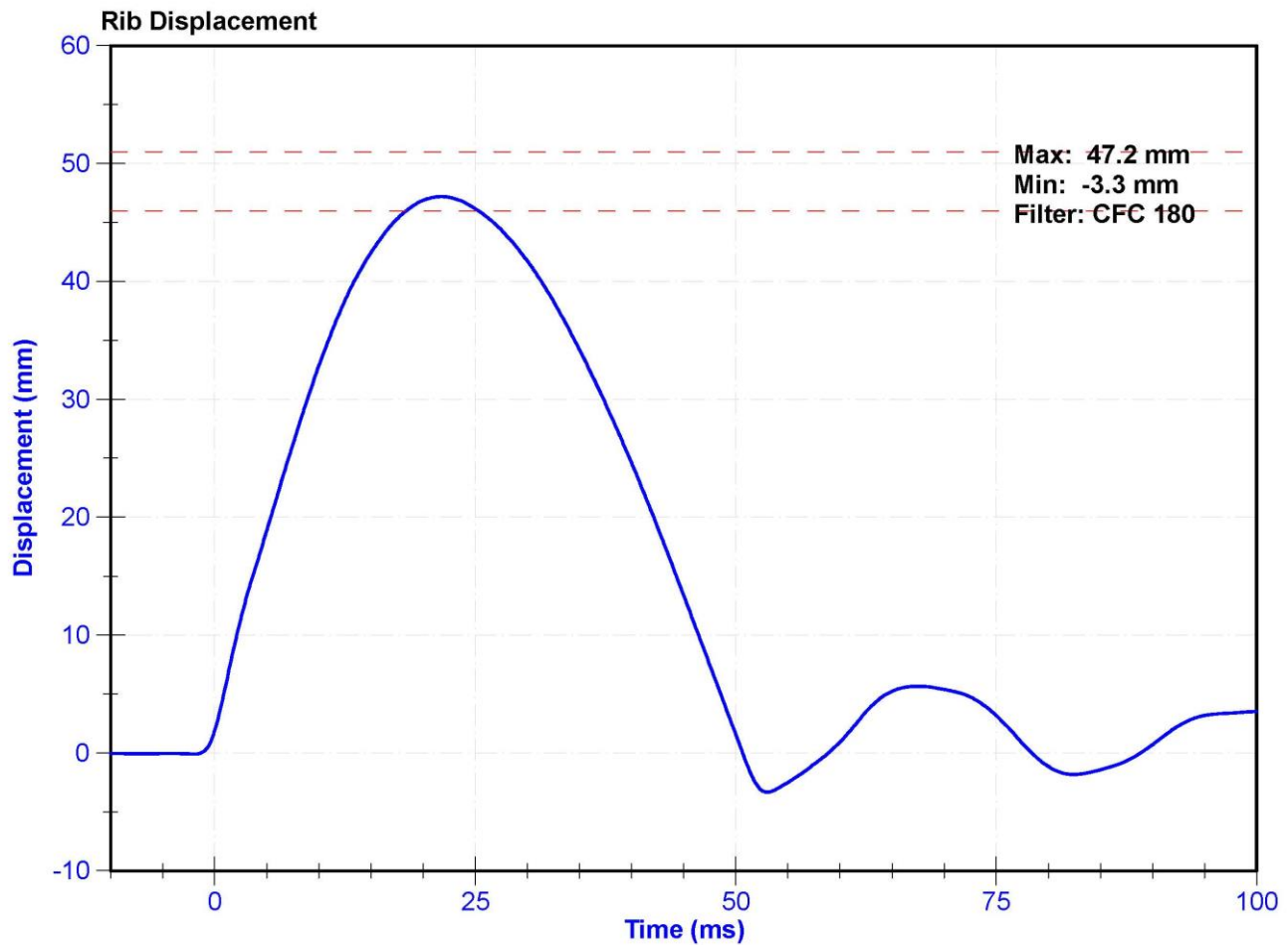
ATD Manufacturer	FTSS	Test Technician	D.Reinhard
ATD Serial Number	DG5348	Laboratory Supervisor	K. Brogan

Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	20.7	Pass
Humidity	10	70	%	44.9	Pass
Rib Displacement	46	51	mm	47.2	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Rib Potentiometer	Honeywell MLT-38000203	DS-268GFE	11/27/2018	11/27/2019



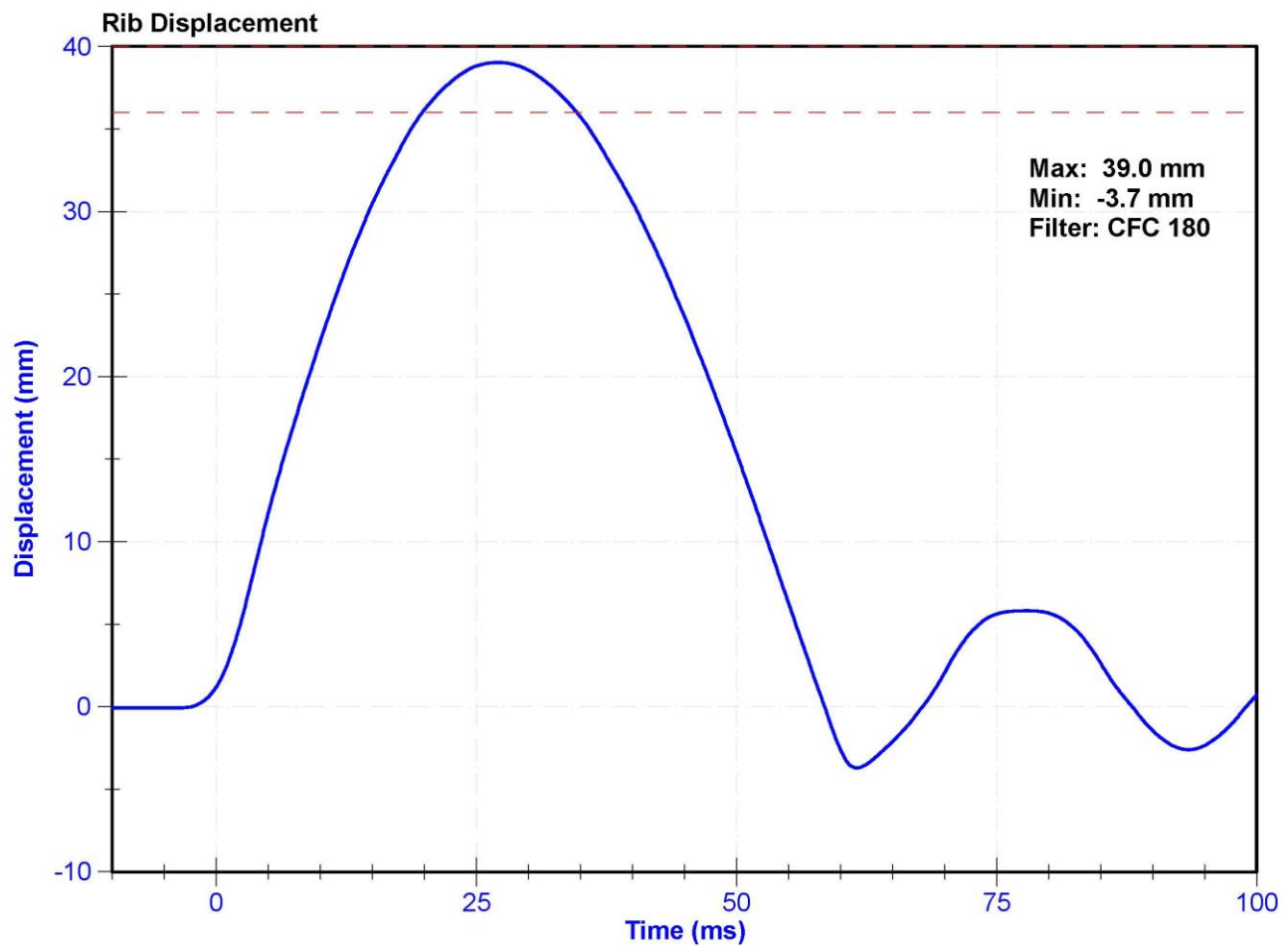
ATD Manufacturer	FTSS	Test Technician	D.Reinhard
ATD Serial Number	DG5348	Laboratory Supervisor	K. Brogan

Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	21.1	Pass
Humidity	10	70	%	43.1	Pass
Rib Displacement	36	40	mm	39.0	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Rib Potentiometer	Honeywell MLT-38000203	DS-269GFE	11/27/2018	11/27/2019



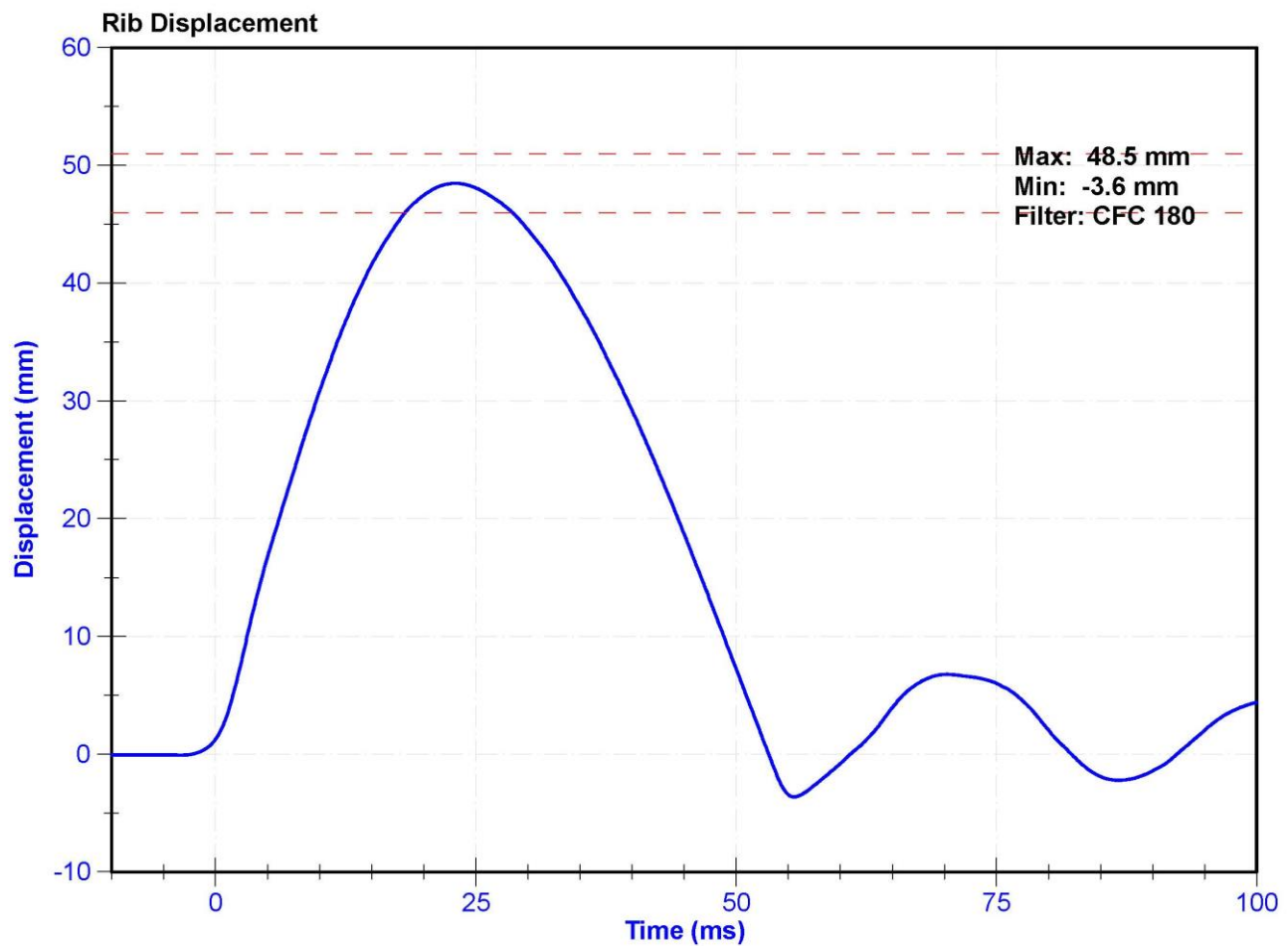
ATD Manufacturer	FTSS	Test Technician	D.Reinhard
ATD Serial Number	DG5348	Laboratory Supervisor	K. Brogan

Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	21.1	Pass
Humidity	10	70	%	43.1	Pass
Rib Displacement	46	51	mm	48.5	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Rib Potentiometer	Honeywell MLT-38000203	DS-269GFE	11/27/2018	11/27/2019



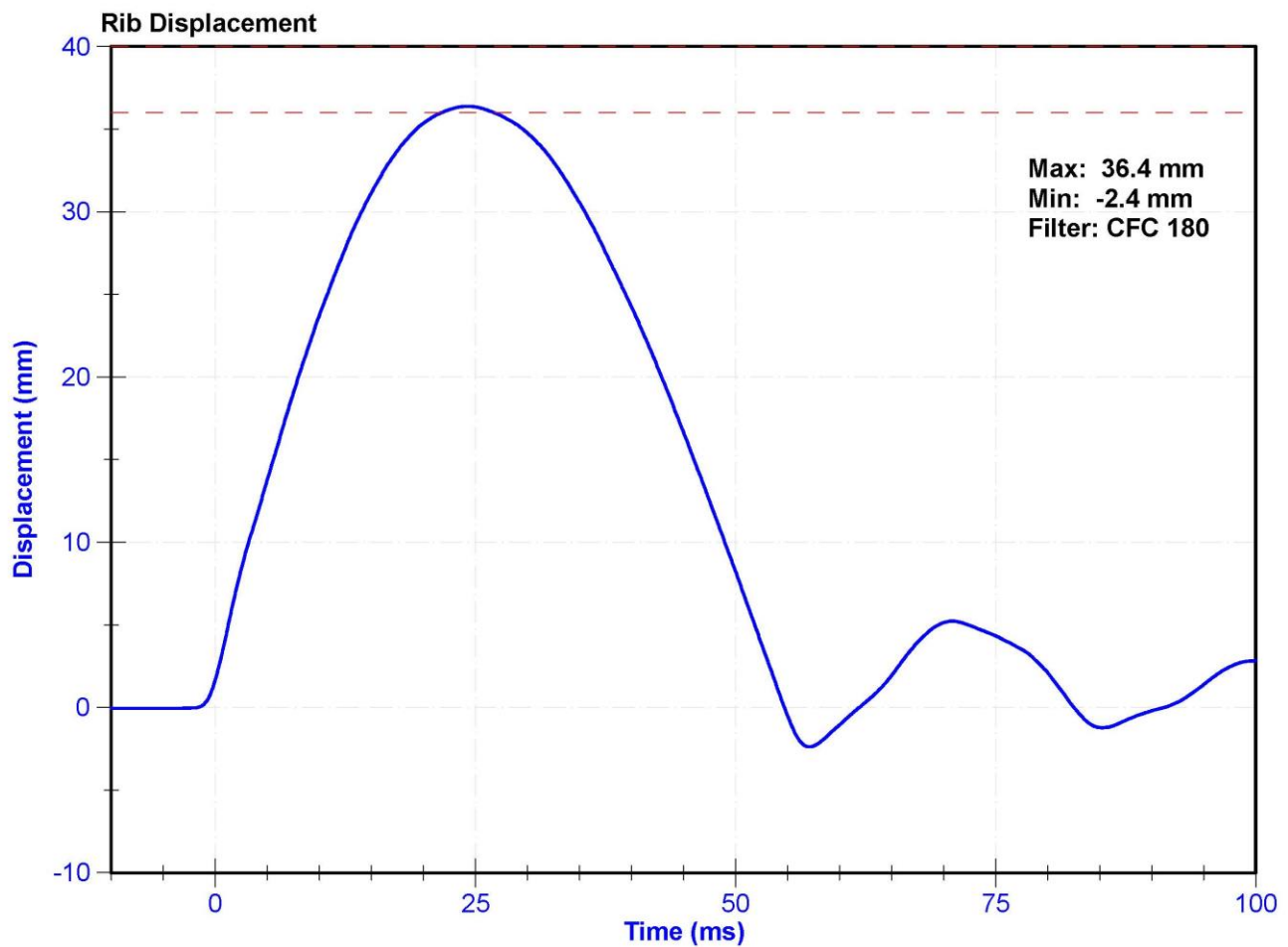
ATD Manufacturer	FTSS	Test Technician	D.Reinhard
ATD Serial Number	DG5348	Laboratory Supervisor	K. Brogan

Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	22.0	Pass
Humidity	10	70	%	16.6	Pass
Rib Displacement	36	40	mm	36.4	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Rib Potentiometer	Honeywell MLT-38000203	DS-270GFE	11/27/2018	11/27/2019



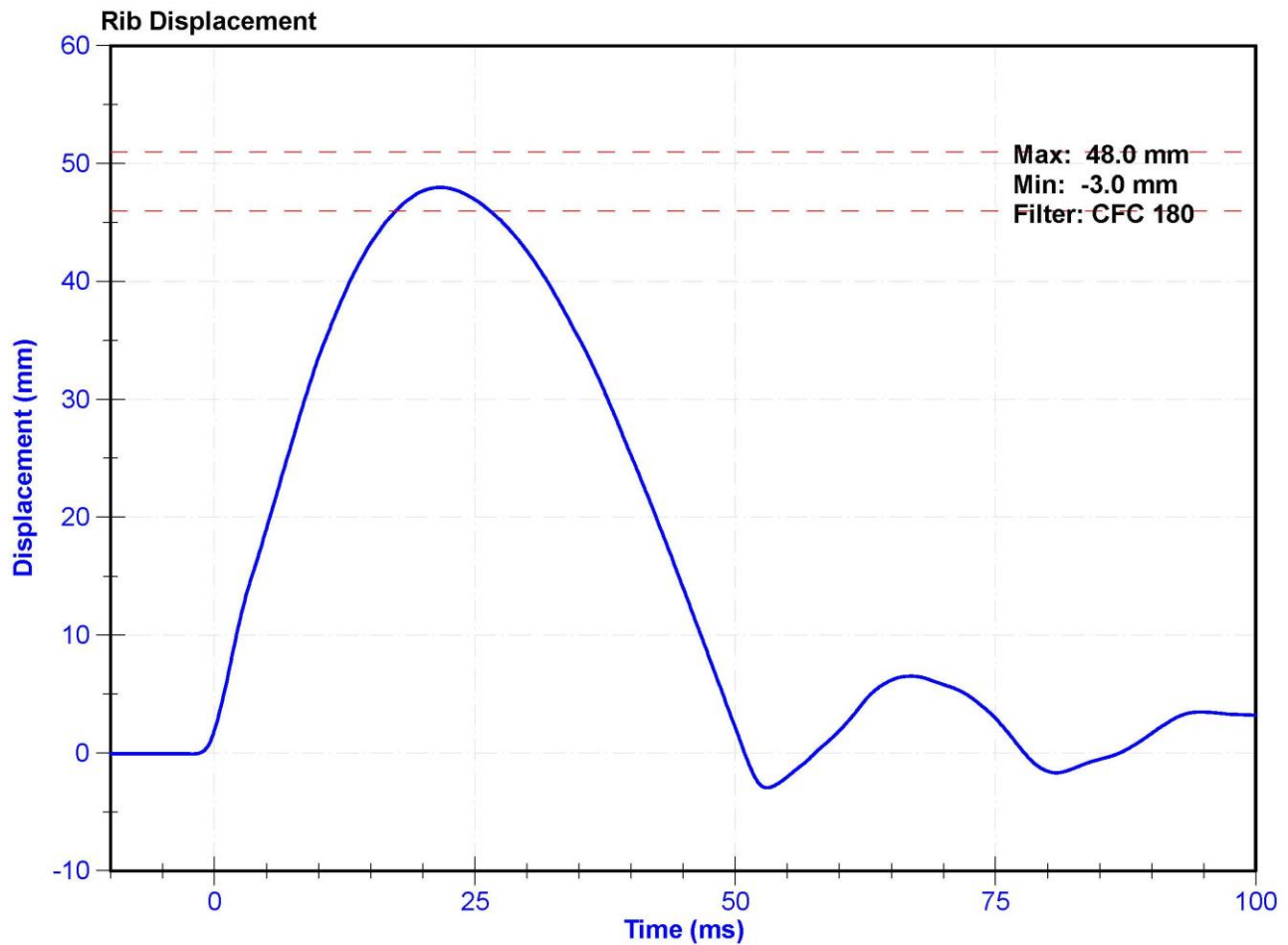
ATD Manufacturer	FTSS	Test Technician	D.Reinhard
ATD Serial Number	DG5348	Laboratory Supervisor	K. Brogan

Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	21.5	Pass
Humidity	10	70	%	44.0	Pass
Rib Displacement	46	51	mm	48.0	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Rib Potentiometer	Honeywell MLT-38000203	DS-270GFE	11/27/2018	11/27/2019



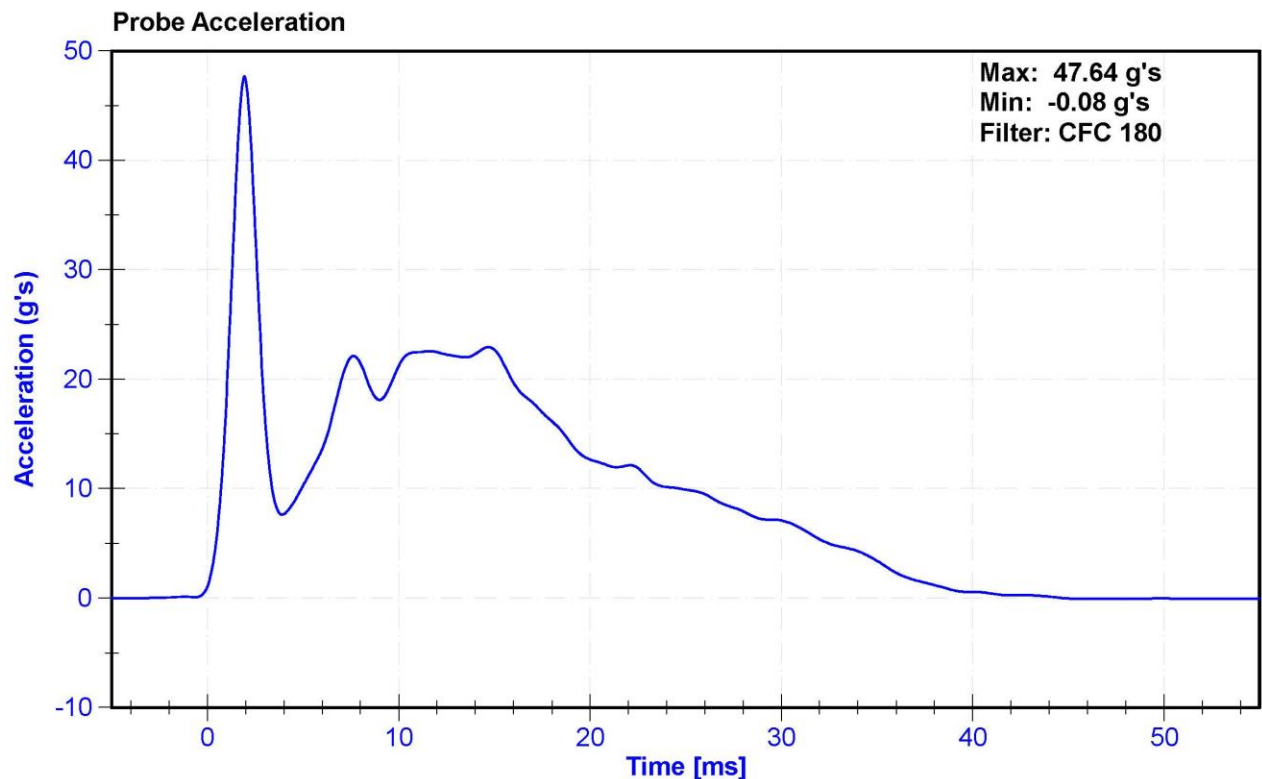
ATD Manufacturer	FTSS	Test Technician	D.Reinhard
ATD Serial Number	DG5348	Laboratory Supervisor	K. Brogan

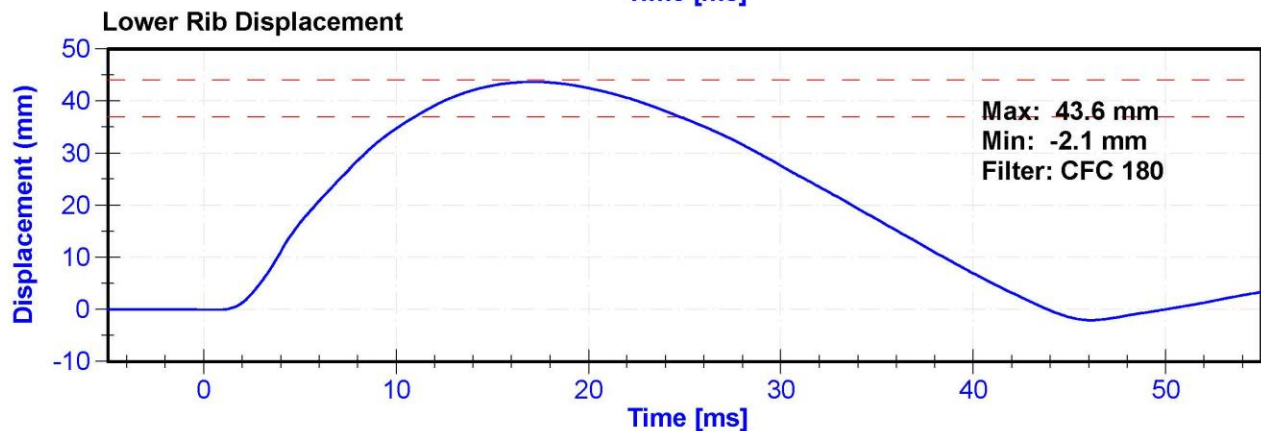
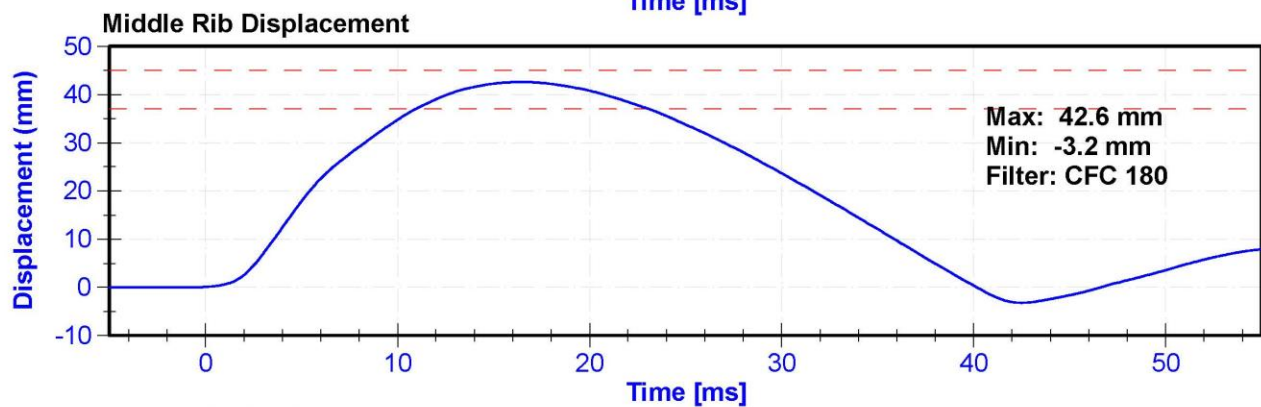
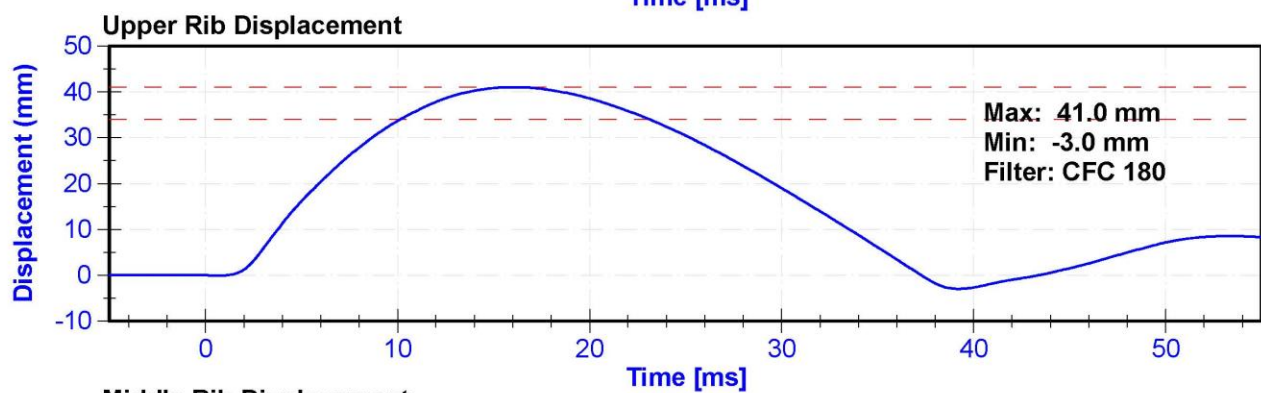
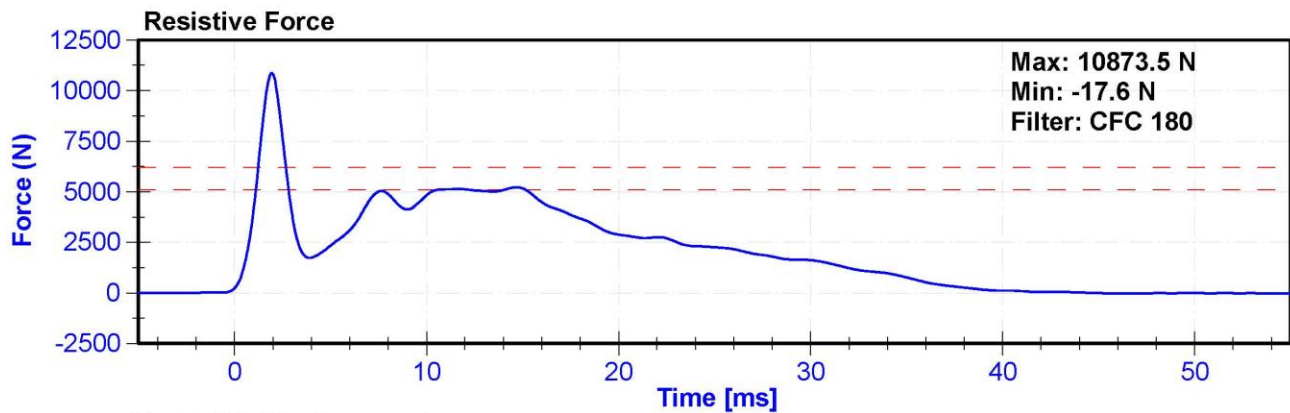
Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	22.1	Pass
Humidity	10	70	%	57.7	Pass
Velocity	5.4	5.6	m/s	5.56	Pass
Resistive Force after 6ms	5100	6200	N	5230.5	Pass
Upper Thorax Rib Deflection	34	41	mm	41.0	Pass
Mid Thorax Rib Deflection	37	45	mm	42.6	Pass
Lower Thorax Rib Deflection	37	44	mm	43.6	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Probe Accelerometer	MSI 64C-2000	A260487	2/21/2019	8/22/2019
Upper Thorax Rib Potentiometer	Honeywell MLT-38000203	DS-268GFE	11/27/2018	11/27/2019
Middle Thorax Rib Potentiometer	Honeywell MLT-38000203	DS-269GFE	11/27/2018	11/27/2019
Lower Thorax Rib Potentiometer	Honeywell MLT-38000203	DS-270GFE	11/27/2018	11/27/2019





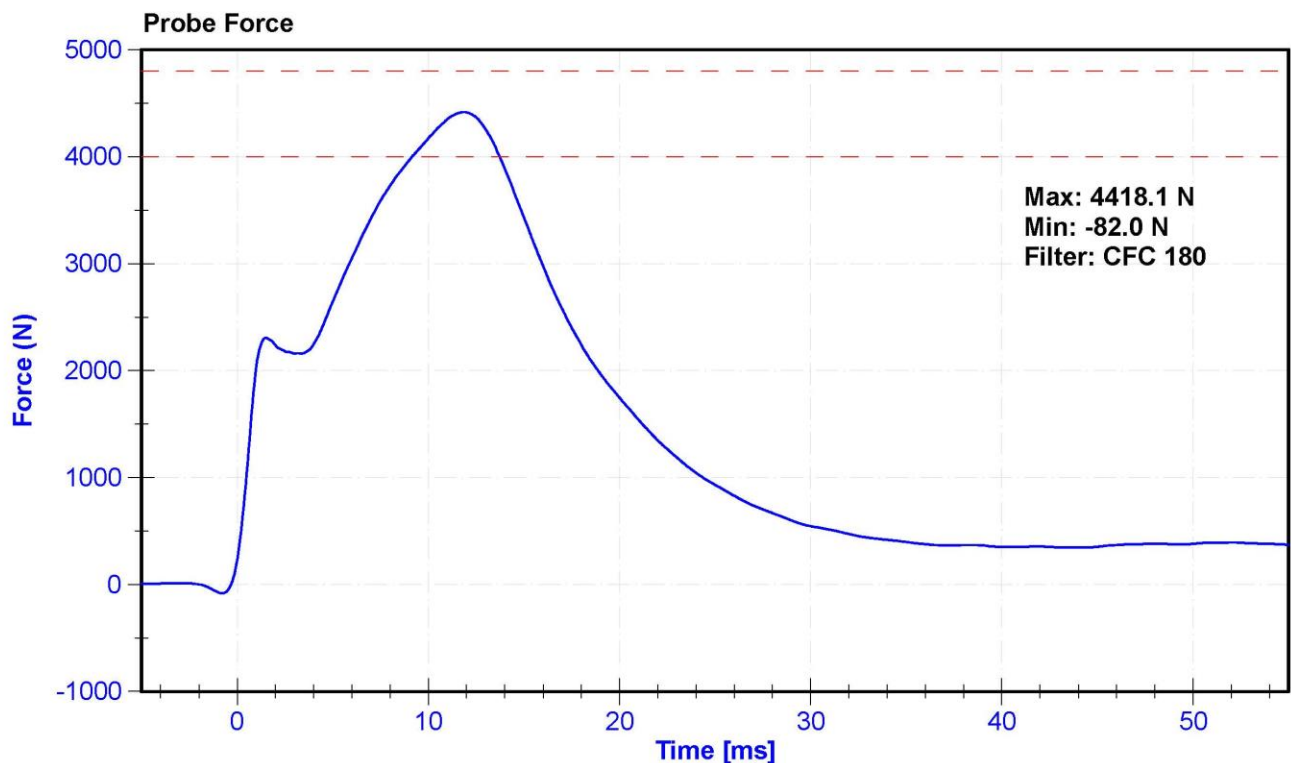
ATD Manufacturer	FTSS	Test Technician	K. Dutton
ATD Serial Number	DG5348	Laboratory Supervisor	K. Brogan

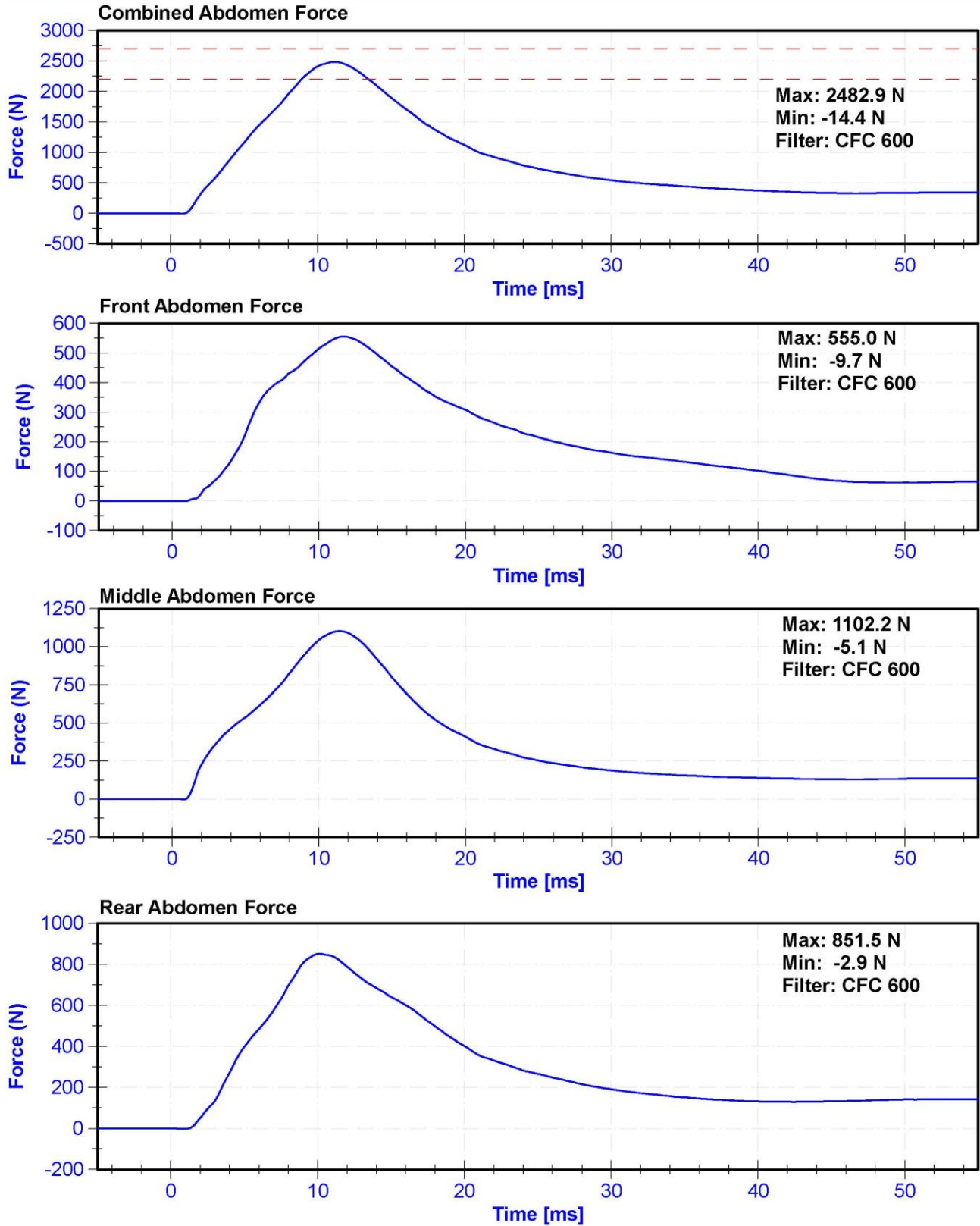
Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	21.9	Pass
Humidity	10	70	%	57.1	Pass
Velocity	3.9	4.1	m/s	4.07	Pass
Combined Abdomen Force	2200	2700	N	2482.9	Pass
Time at Peak Abdomen Force	10.0	12.3	ms	11.15	Pass
Resistive Probe Force	4000	4800	N	4418.1	Pass
Time at Peak Resistive Force	10.6	13.0	ms	11.85	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	MSI 64C-2000	A260487	2/21/2019	8/22/2019
Front Abdomen Load Cell	FTSS 2631	LC-1509	10/4/2018	10/4/2019
Middle Abdomen Load Cell	DENTON 2631	LC-1508	10/4/2018	10/4/2019
Rear Abdomen Load Cell	FTSS 2631	LC-1507	10/4/2018	10/4/2019







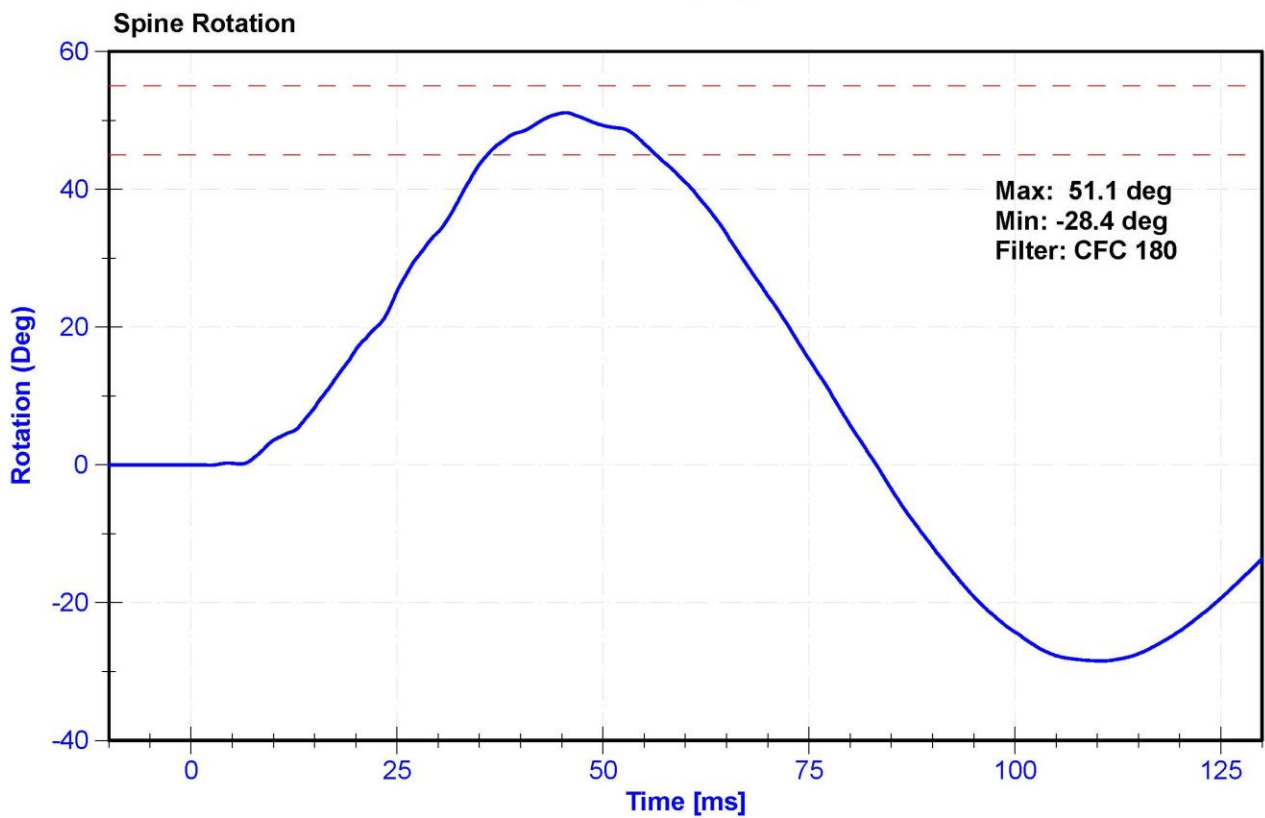
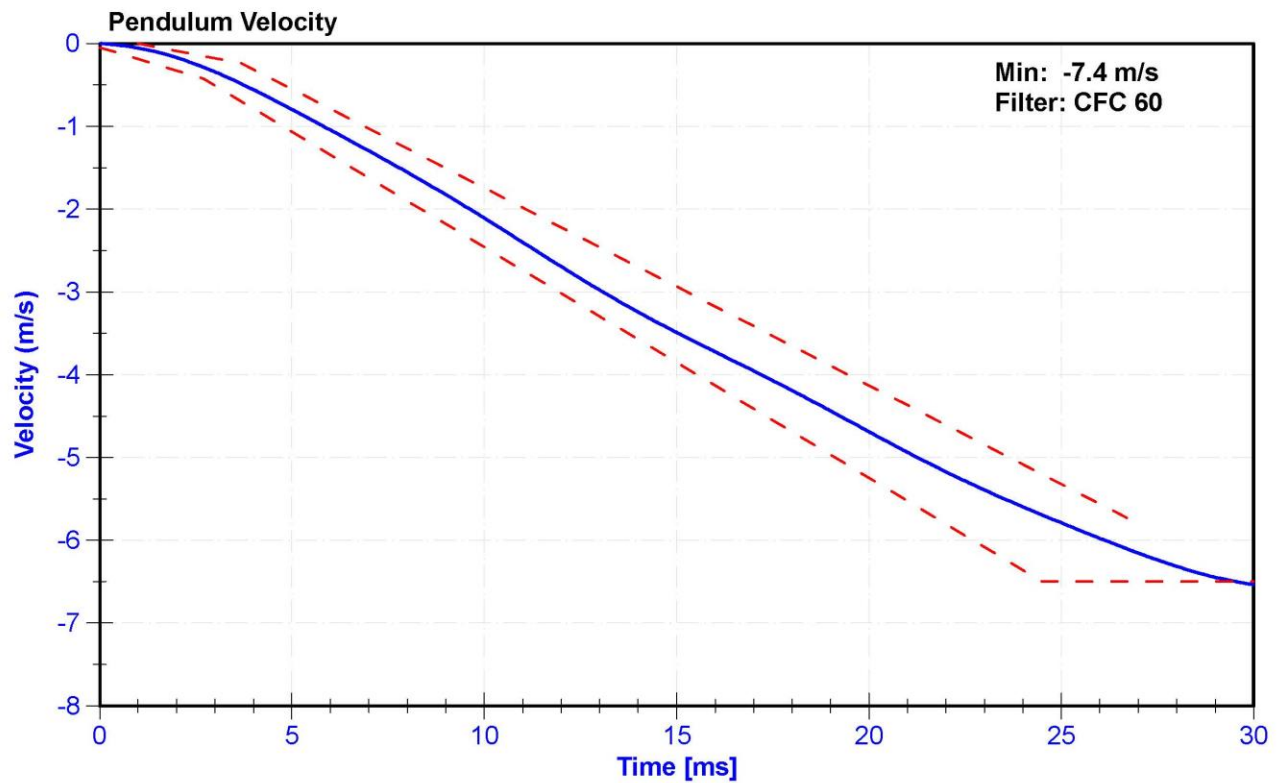
ATD Manufacturer	FTSS	Test Technician	D.Reinhard
ATD Serial Number	DG5348	Laboratory Supervisor	K. Brogan

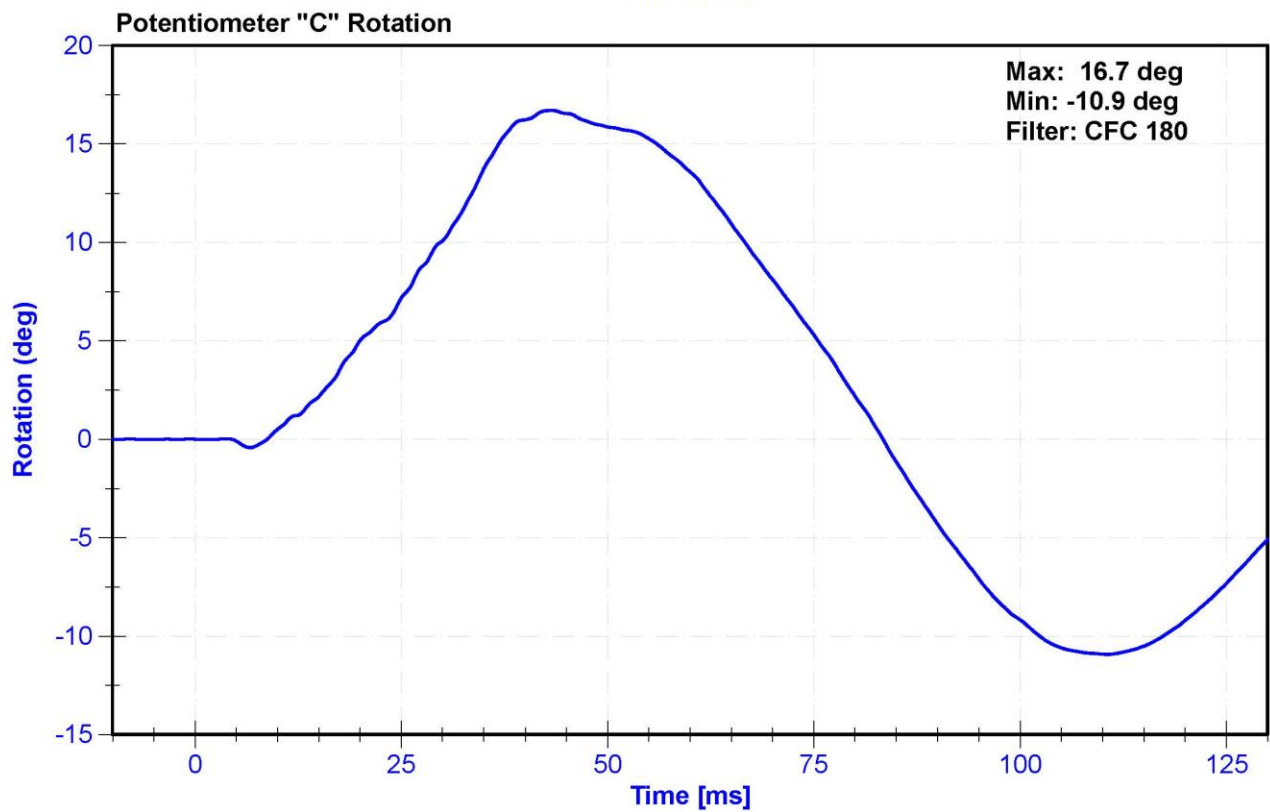
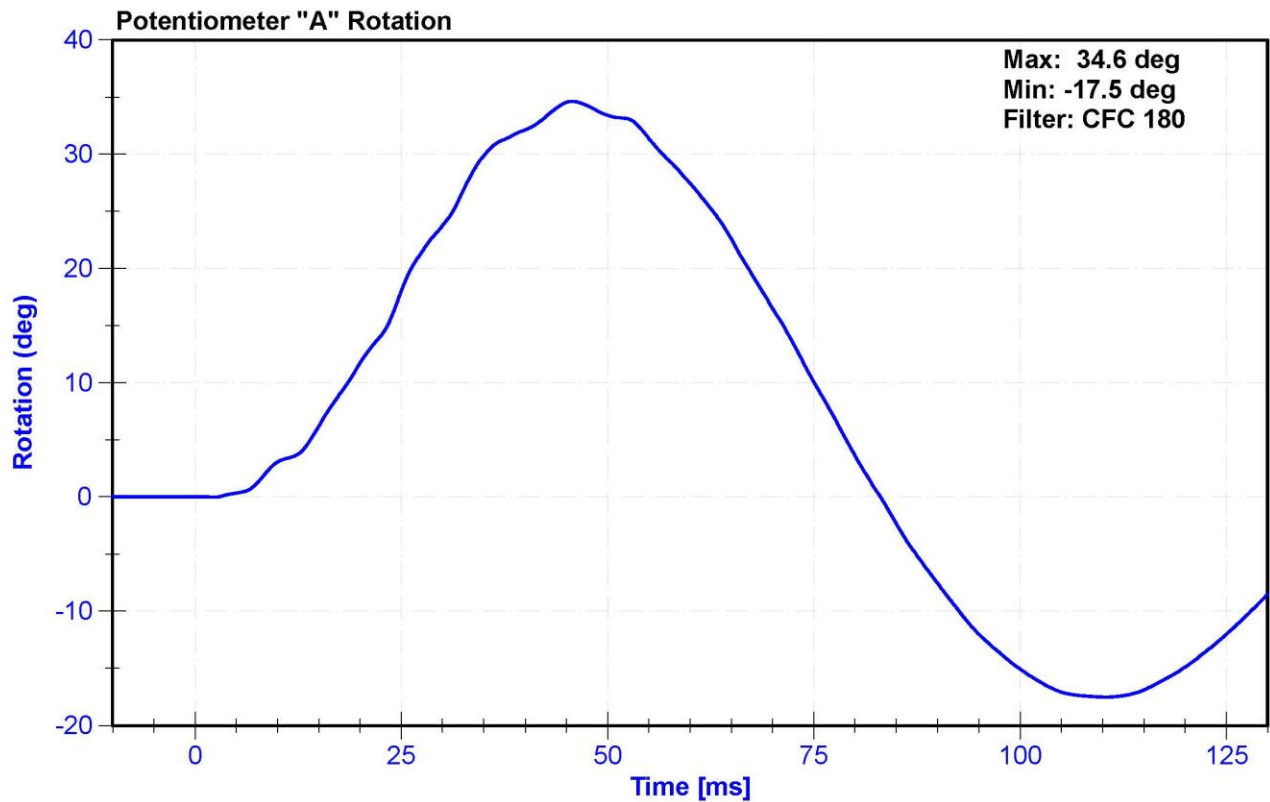
Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	21.8	Pass
Humidity	10	70	%	48.1	Pass
Velocity	5.95	6.15	m/s	6.131	Pass
Lateral Spine Rotation	45	55	deg	51.1	Pass
Time at Maximum Rotation	39	53	ms	45.4	Pass
Time of Decay to Zero Degrees	37	57	ms	37.8	Pass
Pulse within Corridor?	-	-	-		

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	ENDEVCO 7231CT	AC-AH5M9 Pend	1/29/2019	1/29/2020
Pendulum "A" Potentiometer	SP22G	DS-094	10/31/2018	10/31/2019
Condyle "B" Potentiometer	SP22G	DS-095	10/31/2018	10/31/2019





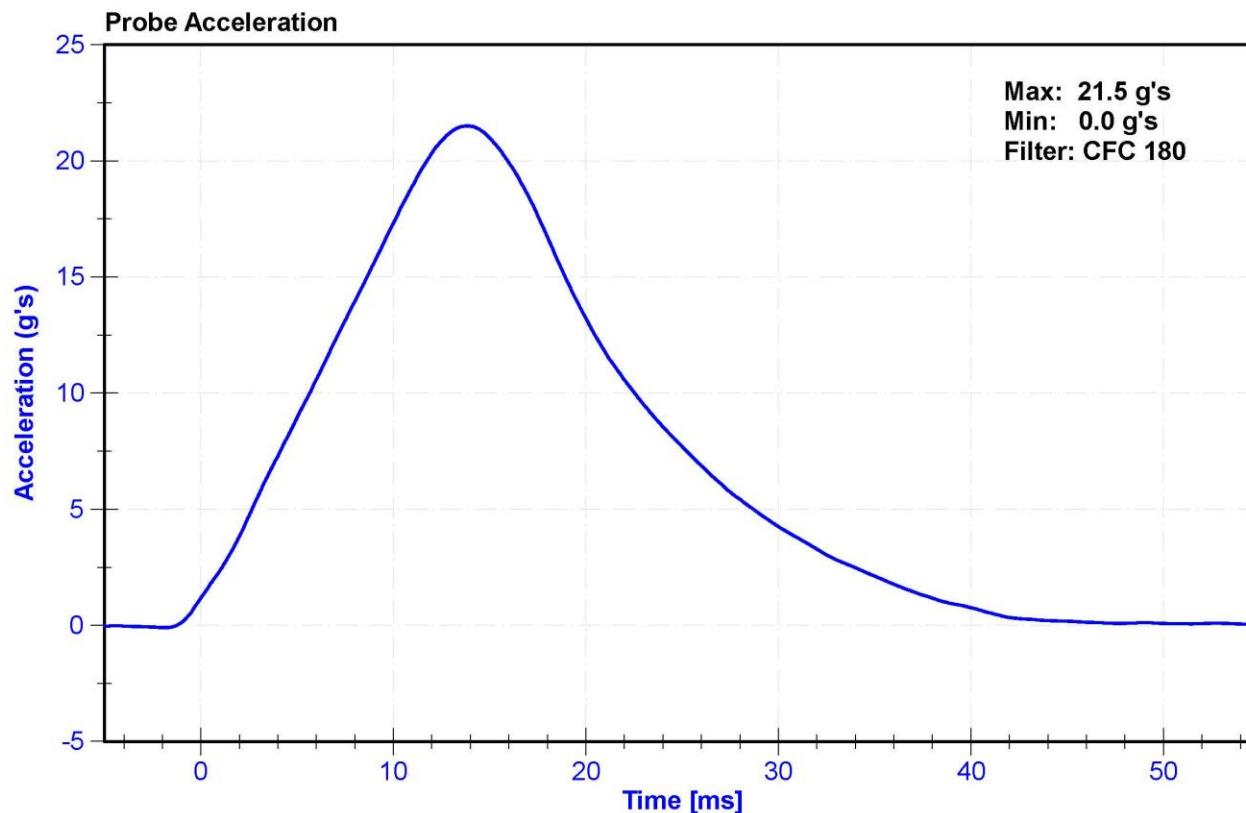
ATD Manufacturer	FTSS	Test Technician	K. Dutton
ATD Serial Number	DG5348	Laboratory Supervisor	K. Brogan

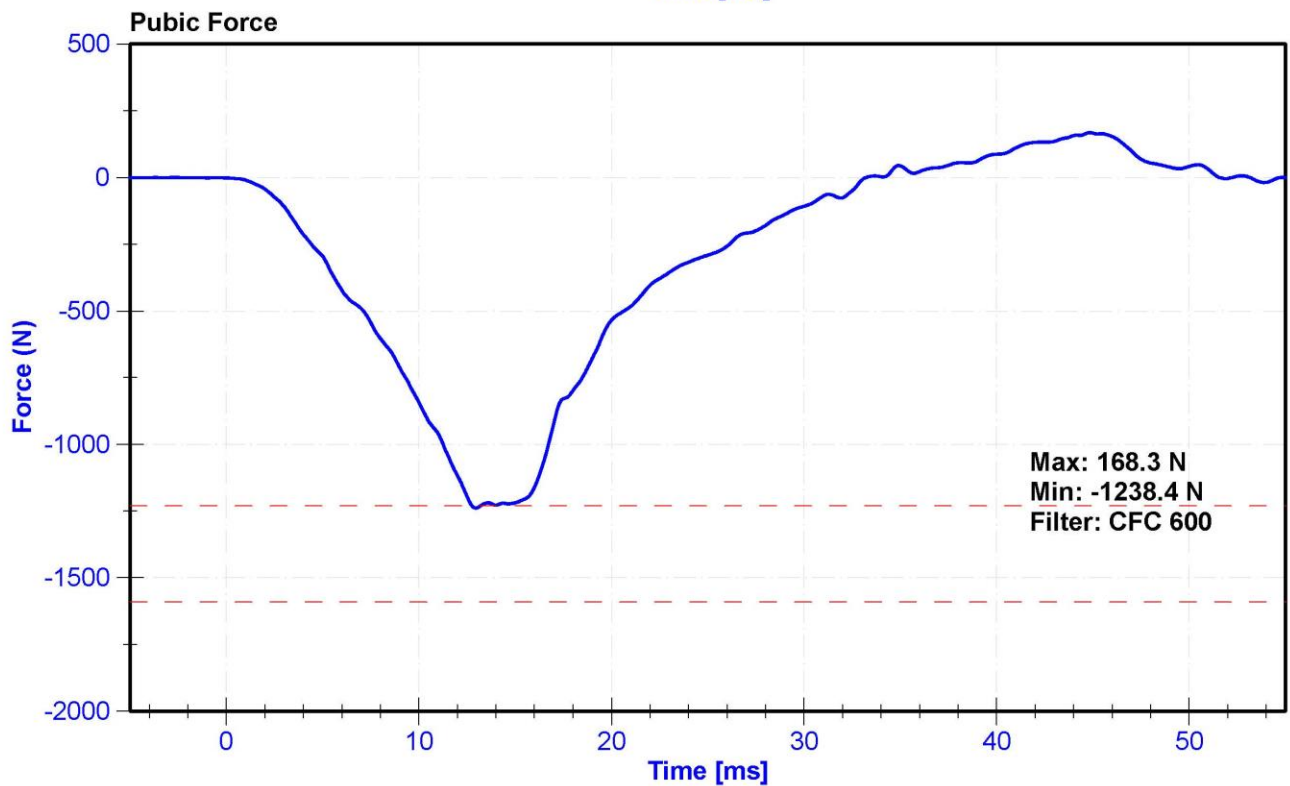
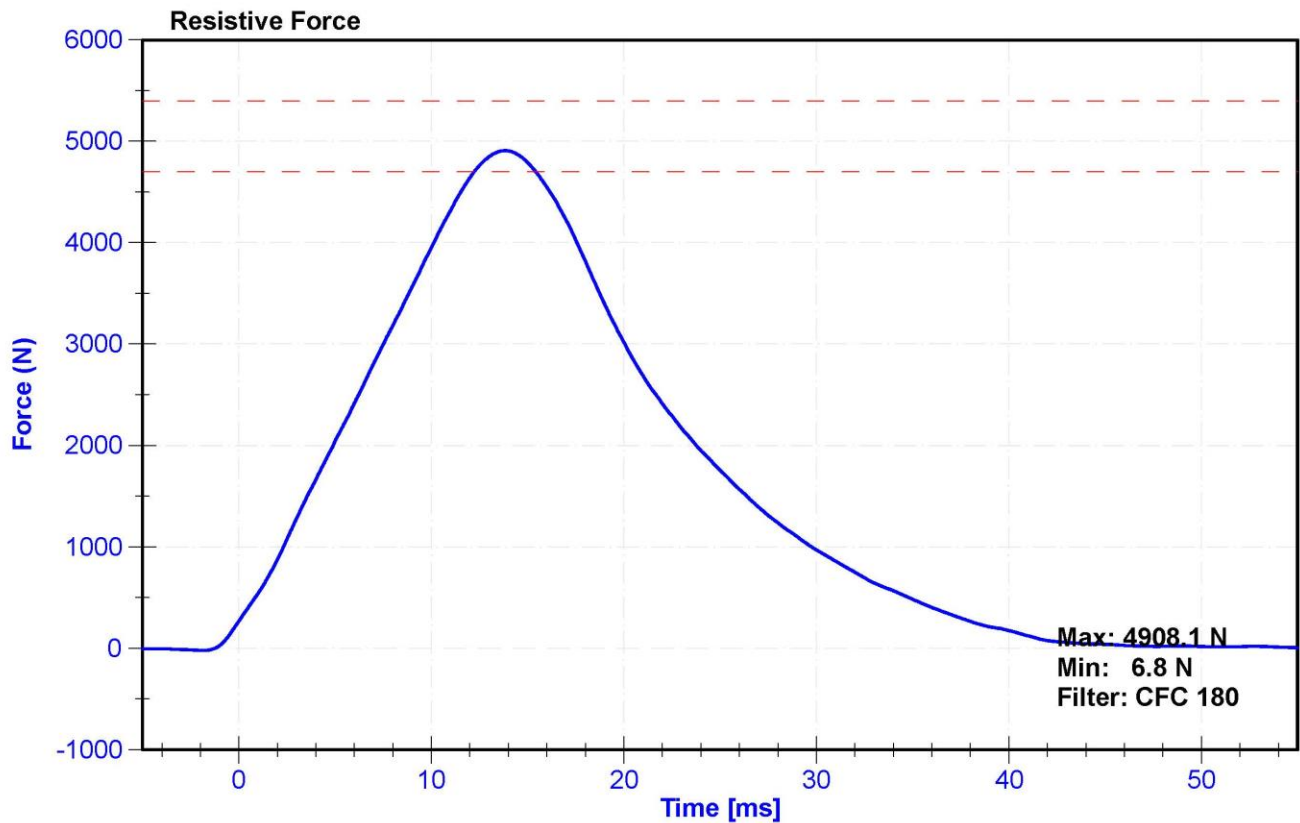
Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	22.0	Pass
Humidity	10	70	%	35.0	Pass
Velocity	4.2	4.4	m/s	4.30	Pass
Resistive Force	4700	5400	N	4908.1	Pass
Time at Peak Resistive Force	11.8	16.1	ms	13.85	Pass
Pubic Force	-1590	-1230	N	-1238.4	Pass
Time at Peak Pubic Force	12.2	17.0	ms	12.95	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	MSI 64C-2000	A260487	2/21/2019	8/22/2019
Pubic Load Cell	FTSS 3096	LC-458	10/4/2018	10/4/2019





APPENDIX V

TEST EQUIPMENT AND INSTRUMENTATION CALIBRATION DATA

Table 1 – Dummy Instrumentation (ES-2re)

			ES-2re S/N: DG5348		
			Serial Number	Manufacturer	Calibration Date
Head Accelerometers	Primary	X	AC-P58757	ENDEVCO	5/9/2019
		Y	AC-P68062	ENDEVCO	5/7/2019
		Z	AC-P68066	ENDEVCO	5/9/2019
	Redundant	X	AC-P51635	ENDEVCO	5/7/2019
		Y	AC-P59001	ENDEVCO	5/7/2019
		Z	AC-P16576	ENDEVCO	5/8/2019
Thorax Rib Displacement Potentiometers	Upper	Y	DS-268GFE	Honeywell	11/27/2018
	Middle	Y	DS-269GFE	Honeywell	11/27/2018
	Lower	Y	DS-270GFE	Honeywell	11/27/2018
Abdomen Load Cells	Forward	Y	LC-1509	FTSS	10/4/2018
	Middle	Y	LC-1508	DENTON	10/4/2018
	Rear	Y	LC-1507	DENTON	10/4/2018
Lower Spine Accelerometers (T12)		X	AC-P51729	ENDEVCO	5/7/2019
		Y	AC-P51873	ENDEVCO	5/7/2019
		Z	AC-P52152	ENDEVCO	5/7/2019
Pubic Symphysis Load Cell		Y	LC-458	FTSS	10/4/2018

Table 2 – Vehicle Instrumentation

Vehicle Instrumentation		Serial Number	Manufacturer	Calibration Date
Vehicle Center of Gravity	X	AC-A250341	MSI 1201-1000	4/23/2019
Vehicle Center of Gravity	Y	AC-A262064	MSI 1201-1000	4/23/2019
Vehicle Center of Gravity	Z	AC-A262922	MSI 1201-1000	4/23/2019
Left Floor Sill	Y	AC-A280857	MSI 1201-1000	4/23/2019
A-Pillar Sill	Y	AC-A280835	MSI 1201-1000	4/23/2019
A-Pillar Low	Y	AC-A281001	MSI 1201-1000	4/23/2019
A-Pillar Mid	Y	AC-A280830	MSI 1201-1000	4/23/2019
B-Pillar Sill	Y	AC-A280195	MSI 1201-1000	4/23/2019
B-Pillar Low	Y	AC-A280936	MSI 1201-1000	4/23/2019
B-Pillar Mid	Y	AC-A281008	MSI 1201-1000	4/23/2019
Passenger Seat	Y	AC-A262927	MSI 1201-1000	4/24/2019
Engine Top	X	AC-A280956	MSI 1201-1000	4/24/2019
Engine Top	Y	AC-A281038	MSI 1201-1000	4/24/2019
Firewall	Y	AC-A279967	MSI 1201-1000	4/24/2019
Left Roof	Y	AC-A281004	MSI 1201-1000	4/23/2019
Right Floor Sill	Y	AC-A279998	MSI 1201-1000	4/23/2019
Rear Floorpan	X	AC-A280173	MSI 1201-1000	4/24/2019
Rear Floorpan	Y	AC-A281028	MSI 1201-1000	4/24/2019